

**SOILS REMEDIAL INVESTIGATION REPORT/
FEASIBILITY STUDY WORK PLAN
(VOLUME II)**

**American Cyanamid Company
Bound Brook, New Jersey**

**October 1990
Amended May 1992**



**BLASLAND & BOUCK ENGINEERS, P.C.
BLASLAND, BOUCK & LEE
ENGINEERS & GEOSCIENTISTS**

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STUDY WORK PLAN
VOLUME II**

**AMERICAN CYANAMID COMPANY
BOUND BROOK, NEW JERSEY**

**OCTOBER 1990
(Amended May 1992)**

**BLASLAND, BOUCK & LEE
RARITAN PLAZA III
FIELDCREST AVENUE
EDISON, NEW JERSEY 08837**

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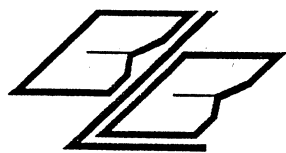
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Attachment 1

ATTACHMENT 1

BEDROCK GROUND-WATER ELEVATION MAP



Attachment 2

ATTACHMENT 2

**NEGATIVE DECLARATION OF PESTICIDE/HERBICIDE
MANUFACTURING OR DISPOSAL**

LEDERLE LABORATORIES



A Division of AMERICAN CYANAMID COMPANY
BOUND BROOK, NEW JERSEY 08809
AREACODE 201-660-2000

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

December 14, 1989

Mr. Roman Luzecky, Case Manager
New Jersey Department of Environmental Protection
Division of Hazardous Waste Management
Bureau of Case Management
401 East State Street - CN-028
Trenton, New Jersey 08625-0028

RE: Herbicide Negative Certification

Dear Mr. Luzecky:

At our August 9, 1989 monthly ACO review meeting, Mr. Johnson requested an additional certification letter stating that herbicides were not produced at the Bound Brook plant to support the deletion of herbicide analysis from our sampling plans. Our initial certification specifically addressed pesticides only because we refer to herbicides and pesticides as pesticides.

The attached certification, therefore, has been revised to specifically address both pesticides and herbicides. We trust this submittal will satisfy Mr. Johnson and that no further action on this matter will be necessary.

Very truly yours,

A handwritten signature in dark ink, appearing to read "Joel Jerome".

Joel Jerome
Environmental Project Manager

JJ/dd

cc: R. L. Hillard - American Cyanamid Company
A. N. Johnson - Blasland, Bouck & Lee

To: J. Jerome Date: August 15, 1989
Location: Bound Brook Copy to:
From: A. J. Dawson
Location: Wayne
Extension: 3989
Subject: PESTICIDE NEGATIVE CERTIFICATION
Reference:

The list of pesticides and herbicides you provided (attached) was reviewed by Agricultural Manufacturing personnel. None of the listed materials are known to have been made for the Agricultural Division at Bound Brook, to the best knowledge of Agricultural Manufacturing Personnel.

Materials that are known to have been produced included AVENGE®, 4-NO_x, Famphur and Dodine.


A. J. Dawson

AJD:dm
dm718
Attach.

JOEL JEROME

AUG 17 1989

Y
Y
Y
Y

Y
Y

Y
Y
Y
Y
Y
Y
Y
Y
Y
Y

To: J. Jerome

Date: January 19, 1990

Location: Bound Brook

Copy to:

From: A. J. Dawson

Location: MB-3

Extension: 4983

Subject: PESTICIDE NEGATIVE CERTIFICATION

Reference: 1) Memorandum A. J. Dawson to J. Jerome, 8/15/89

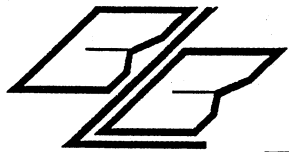
Both 2,4-D and 2,4,5-TP were reviewed by Agricultural Manufacturing Personnel, in addition to the list of pesticides and herbicides previously provided (Ref. 1). Neither 2,4-D nor 2,4,5-TP are known to have been made for the Agricultural Division at Bound Brook to the best knowledge of Agricultural Manufacturing Personnel.

A. J. Dawson
A. J. Dawson

AJD:rb

JOEL J. JEROME

JAN 23 1990



Attachment 3

ATTACHMENT 3
HYDROGEOLOGIC INVESTIGATION PROGRAM

HYDROGEOLOGIC INVESTIGATION PROGRAM

AMERICAN CYANAMID

1.0 INTRODUCTION

As part of the Soils RI Report/FS Work Plan conducted at the American Cyanamid, Bound Brook, New Jersey facilities, an evaluation and interpretation of the subsurface soil and ground-water conditions beneath the site were performed. This appendix summarizes the field activities and presents a discussion of the encountered hydrogeologic conditions. General information on the location, physiography, and historic background of the facility are presented in Section 2 of the Soils RI Report/FS Work Plan.

2.0 OBJECTIVE AND SCOPE OF WORK

The objective of this investigation was to evaluate and interpret the geology and hydrology of the Cyanamid Bound Brook site to the extent necessary to assist in the delineation of the distribution of contaminants in the subsurface across the site.

The site investigation was conducted from July through October 1989, as outlined in the Soils RI Report/FS Work Plan, prepared by Blasland, Bouck and Lee and dated January 1989. This program included the following tasks:

1. review of existing hydrogeologic information;
2. drilling and sampling of soil borings;
3. installation of ground-water monitoring wells; and
4. measurements of ground-water elevations.

Upon completion and review of the data acquired from these activities, supplemental work to refine the hydrogeologic information obtained during the initial investigation was performed. The supplemental activities included:

1. installation and slug testing of 11 piezometer clusters;
2. collection of ground-water level measurements; and
3. installation of a still well in Cuckolds Brook.

These activities were completed between May and September 1990.

3.0 REVIEW OF EXISTING INFORMATION

A significant amount of information exists on the site because of the numerous geologic and hydrologic investigations completed since the late 1970s. Previous investigation reports were reviewed, and a data base of existing information was compiled. This information was supplemented by the work completed as part of the Soils RI Program. One item of importance derived from the existing report review is the compilation of boring and well logs utilized to develop the current site stratigraphy. Other important information included the ground-water flow regime and hydrologic parameters of the bedrock aquifer system. However, previous reports did not provide information on the hydrogeology of the unconsolidated deposits in the Main Plant area. In addition, the existing information has never been unified into a site-wide synthesis of geohydrologic conditions.

4.0 SOIL INVESTIGATIONS

A total of 48 soil borings and 31 monitoring well borings were drilled to evaluate the hydrogeology of the manufacturing area. The soil borings

were advanced through the fill layers and terminated either in native soils or at the bedrock surface. Monitoring well borings were subsequently completed as wells, except where ground water was not encountered.

The soil borings were advanced by driving a 2-inch OD split spoon sampler ahead of a 4.25-inch Hollow Stem Auger, using either a 140 or 300 pound hammer, dependent upon soil compaction and particle size. Following the completion of the boring, the borehole was tremie grouted with cement/bentonite grout to above the water table and then backfilled with cuttings. Boreholes that were drilled and sampled as part of a well installation were completed as ground-water monitoring wells.

A record of the field activities, including samples collected, lithologies encountered, ground-water elevations, drilling characteristics and data, was maintained in a series of bound field logs.

Thirty-eight of the reference split-spoon samples collected from the soil and well borings were submitted to Haller Testing Laboratories, Inc., Plainfield, New Jersey, for particle size analysis in order to confirm field classifications and quantify the grain-size distribution of the site soils. The coarser (sand and gravel) fraction samples were tested by a sieve analysis, and the finer (clay and silt) fractions were tested by a hydrometer analysis. The samples were tested in accordance with ASTM Test Method D-422 for sieve analyses and, where applicable, hydrometer analysis.

Soil boring and monitoring well locations are shown on Figure 9 of the Soils RI Report/FS Work Plan. Copies of the soil borings are included in Appendix A-2; copies of the ground-water monitoring well boring logs are

included in Appendix A-4; and copies of the grain size distribution curves are included in Appendix A-6.

5.0 GROUND-WATER INVESTIGATIONS

5.1 Monitoring Well Network

The overburden ground-water monitoring system was designed and installed to gather information from the entire overburden unit and to supplement the soil boring portion of the investigation.

The wells were permitted, in accordance with NJAC 58:4A-14 et seq., installed, and subsequently developed by Empire Soils Investigations, a state of New Jersey licensed well driller. The installation and development of the monitoring wells was initiated on August 14, 1989, and completed on October 23, 1989. Only 28 of the 31 monitoring-well borings that were drilled were completed as wells because ground-water was not encountered in borings MW-4, MW-11, and MW-14.

All ground-water monitoring wells were constructed in accordance with the NJDEP Monitoring Well Specifications For Unconfined Unconsolidated Aquifers. The wells were constructed using 4-inch OD schedule 40 PVC, flush joint well screen, and riser installed in an 8-inch borehole. The borehole was advanced to bedrock. The wells were screened using .010-inch slotted PVC screen, positioned from the top of the bedrock to two feet above the level where water was first encountered. The annulus between the screen and the borehole was sand-packed with Jesse Morie Number 1 filter sand. A one-foot thick bentonite pellet seal was installed immediately above the gravel

pack. The remainder of the annular space was backfilled by tremie grouting to ground surface with a cement/bentonite grout. The grout was allowed to set for 24 hours and was then topped off at the surface. The locking steel protective casings and concrete pads were installed simultaneously.

Approximately one week after installation the wells were developed by surging and pumping until low turbidity water was obtained. The time spent on well development, the physical appearance of the well water, the yield of each well, and the amount of water removed during development were recorded in the field log book.

Upon completion, the geographic coordinates and elevation of the monitoring wells were established by a state of New Jersey licensed surveyor.

The locations of the overburden ground-water monitoring wells are shown on Figure 9 of the Soils RI Report/FS Work Plan. The monitoring well boring logs and construction details are included as Appendix A-4 of the Soils RI Report/FS Work Plan.

5.2 Piezometers

The water levels in the wells that were installed in the initial phase of field work indicated that a complex relationship exists between the overburden water producing units. In addition, the relationship between the overburden aquifer system and the shallow bedrock aquifer had never been directly investigated.

To refine our understanding of the ground-water flow conditions within each water producing unit and evaluate the relationship between the overburden water-producing units and the shallow bedrock aquifer, a network

of 11 multi-level piezometer clusters were installed. The piezometers were screened at select intervals within the overburden and/or upper fractured zone of the bedrock to measure the flow potential components between and within the different units. The piezometers were designated, based on the screened interval, as water table (W), intermediate (I), deep (D) overburden piezometers, and shallow bedrock (R) piezometers.

To obtain site-wide coverage for the purpose of generating potentiometric surface contour maps, the clusters were distributed throughout the Main Plant area. To evaluate the relationship of the main overburden deposits on the ground-water flow regime, piezometer clusters were located in areas representative of the observed subsurface conditions throughout the site. To evaluate the relationship between the overburden aquifer system and the shallow bedrock aquifer, particularly the effect of the bedrock transmissive zones, piezometer clusters with a bedrock component were installed across the study area and distributed to cover both areas where the transmissive zones are expected to subcrop and areas where relatively low transmissivity bedrock is expected to subcrop.

The piezometers were permitted in accordance with NJAC 58:4A-14 et seq. installed, and subsequently developed by Empire Soils Investigations, a state of New Jersey licensed well driller. The installation and development of 34 piezometers was initiated on July, 16 1990, and completed on August 3, 1990.

The overburden components of the piezometer clusters were constructed following the guidelines of the NJDEP Monitoring Wells Specifications For Unconfined Unconsolidated Aquifers. The wells were constructed using a 2-

inch OD schedule 40 PVC, flush joint, well screen, and riser installed in a 6-inch borehole. The overburden piezometers were screened across specific pre-determined intervals, with 3-foot long, 0.010-inch slotted PVC screen section. The water table piezometers were screened across the water table in the manmade fill. The intermediate piezometers were screened in the upper portion of the sand and gravel unit, immediately below the silt and clay. The deep piezometers were screened in the basal part of the sand and gravel unit, immediately over the bedrock. The annulus between the screen and the borehole was sand-packed with Jesse Morie Number 1 filter sand. A 1-foot thick bentonite pellet seal was installed immediately above the sand pack. The remainder of the annular space was tremie grouted to ground surface with a cement/bentonite grout. The grout was allowed to set for 24 hours, was topped off to surface, and a locking steel protective casing and concrete pad were installed.

The bedrock components of the piezometer clusters were constructed following the guidelines of the NJDEP Monitoring Wells Specifications For Bedrock Formations, by tremie grouting a 4-inch ID steel casing into an 8-inch ID borehole which was augered 5 feet into bedrock. Additional grout was added to the borehole as the grout settled. The casings were allowed to set for a minimum of 72 hours before the well was extended further into the rock by using a 3-7/8-inch OD roller bit and an air rotary method of drilling. After the completion of the well, a cement collar, pad, and locking steel protective casing were installed.

The piezometers were developed approximately one week after installation. This was by utilizing one of three methods:

1. Surging and pumping with a centrifugal pump the shallow piezometers;
2. Hand bailing the slow recovering piezometers;
3. Oil-less air compressing and double pipe airlifting for the bedrock piezometers.

The time spent on development, the physical appearance of the purged water, the yield, and the amount of water removed during development was recorded in the field log book.

Upon completion, the geographic coordinates and elevation of the piezometers were established by a state of New Jersey licenced surveyor.

Locations of the piezometer clusters are shown on Figure 9 of the Soils RI Report/FS Work Plan. The piezometer boring logs and construction details are included in Appendix A-5 of the Soils RI Report/FS Work Plan.

Five rounds of ground-water elevations were collected in these piezometers between August 4, 1990, and August 21, 1990. Ground-water elevation contours are included as Figures 2 through 21. Data used to construct these figures are listed on Table 1 of this attachment.

5.3 Piezometer Slug Testing

To evaluate the aquifer parameters of the manmade fill and sand and gravel water bearing units the water table, intermediate, and deep piezometers were slug tested.

The slug test is performed by inserting a metal slug into the piezometer, thus displacing the standing water and causing the water level in the piezometer to rise. As the water level begins to fall, the rate of subsidence

is measured until the water surface returns to its initial level. After the water level has returned to its pre-insertion level, the slug is removed, causing the water level to drop. The rate of recovery is measured, until the water level reaches equilibrium.

The method of Cooper, Bredehoefer, and Papadopoulos and the method of Bouwer and Rice were evaluated for their applicability in reducing the data. The method of Cooper, Bredehoefer, and Papadopoulos assumes that the aquifer is confined, the well is screened across the total thickness of the aquifer, and the transmissivity of the aquifer is low. This method is applied by generating a semilogarithmic plot of residual drawdown versus time, which is then matched to a set of type curves. Successive type curves differ very little in shape but yield answers that are different by one order of magnitude, thus introducing a significant error margin.

The method of Bouwer and Rice assumes that the aquifer is unconfined, but can also be applied to confined situations when there is an internal source of water such as recharge through the confining layer. This method allows for calculation of the hydraulic conductivity from the geometry of the aquifer, the geometry of the well, and the observed drawdown versus time. Since the aquifer parameters are derived by direct calculation, this method yields results that are more reliable than curve fitting, particularly with rapidly responding wells.

Based on these considerations, the method of Bouwer and Rice was elected. Calculation sheets are presented in Appendix I of this attachment.

Regardless of which method is employed in reducing the data, slug tests yield numbers that are general indicators of aquifer properties rather

than accurate determinations of properties. However, the simplicity of the field procedure yields a large number of data points in a short period of time and constructs a picture of the variability of the aquifer properties across the site area.

5.4 Still Well

On August 20, 1990, a still well was installed in Cuckolds Brook to measure stream water surface elevation. The still well was installed by the railroad bridge which crosses the brook south of the Main Plant (Figure 9 of the Soils RI Report/FS Work Plan). The still well was constructed by seating a section of 4-inch ID PVC well screen in the stream bed and extending the well above the water surface. A length of 1-inch PVC pipe was secured to the bridge structure with one end extending inside the well screen and the other extending up to the track grade. Following the installation of the still well, the elevation of the top of the PVC pipe was surveyed to provide a measuring datum.

6.0 SITE GEOLOGY

6.1 Stratigraphy

The site stratigraphy is relatively simple, comprised of a thin veneer of unconsolidated sediments (man-placed fills and natural alluvium) overlying the sedimentary redbed shale and siltstone units of the bedrock (Figure 22).

6.2 Bedrock

The site is underlain by the Passaic Formation of the Newark Supergroup (Olsen, 1980) and this formation corresponds to the pre-Watchung equivalent of what is commonly referred to as the Brunswick Shale. The Passaic Formation is a series of red siltstones, sandstones, and conglomerates, with occasional clusters of non-red detrital material interspersed along the section. The maximum estimated thickness of the Passaic formation reaches 6,000 meters (approximately 4 miles).

The Passaic Formation is involved in the Watchung syncline and may be affected by parasitic folding associated with the braided fault system connecting the Ramapo and Hopewell faults (Figure 23). A combination of these features can locally give rise to complicated structures. Based on outcrop information previously collected in the vicinity of the site, the bedding of Passaic formation parallels the trend of the Watchung Mountains.

The bedrock surface has been modified by erosion (Figure 24) and boring data indicates the presence of a buried ancestral river drainage. The location and origin of these features is important in understanding the distribution and composition of the water-bearing units and the ground-water flow regime in the overburden aquifer system.

The western part of the site subsurface, in the vicinity of Lagoons 8 Complex, is occupied by a bedrock high, probably a terrace escarpment, the sides of which are incised by deep, rapidly descending V-shaped valleys. These valleys are oriented in a general north-south direction and lead either towards the Raritan River or towards the Main Plant area.

The area underlying Lagoon 7 Complex is a low-lying bedrock flood plain. The bedrock surface exhibits little relief, and the reconstruction of the bedrock surface is constrained. Most of the area is occupied by the Lagoon 7 Complex, thus limiting the available boring data.

The bedrock surface underlying the manufacturing area is eroded into a sinuous valley. This valley has an outlet to the present Raritan River channel through the area between Lagoon 15 Complex and Lagoon 1 Complex. The eastern extend of the valley cannot be fully evaluated due to absence of data east of the Main Plant area. The western limit of the buried valley approximately coincides with the limits of the West Yard and is partially connected to the features underlying the Lagoon 8 Complex.

6.3 Unconsolidated Deposits

The site is underlain by a cover of unconsolidated sediments ranging in thickness from 5 to 30 feet. These sediments are comprised of a residual soil overlain by alluvial deposits and in the Main Plant area, the natural sediments are covered by a 2 to 4 foot thick layer of manmade fill.

The residual soil is the weathering product of the bedrock and consists of a 2 to 3 foot thick mixture of silt, clay, and shale fragments. This unit has been eroded away and is missing in places.

The alluvial deposits consist of interfingering and/or interbedded gravels, sands, silts, and clays. The lower part of the alluvial deposit sequence is occasionally occupied by a low energy deposit. Overlying these fines is a sequence of sand and gravel mixtures which generally grade finer upwards. These sands and gravels occupy bedrock valleys, are thickest near their axes

and become thinner and finer grained away from their axes. The sand and gravel deposits are thinnest, and at times altogether absent over bedrock ridges which represent the banks of the buried river channels.

The grain size distribution curves of the sand and gravel unit are generally skewed due to the presence of significant quantities of silt and clay (up to 20 percent by weight). The mean grain size ranges from 0.025 mm to 7.8 mm, while the maximum particle size ranges up to 40 mm, indicating a skewing towards finer grain sizes. Copies of the particle distribution curves are included in Appendix A-6 of the Soils RI Report/FS Work Plan.

The sand and gravel deposits grade upwards into or are truncated by silt and clay flood plain deposits. The silt and clay unit is missing in parts of the Main Plant and West Yard (Figure 25). In these cases, the manmade fill is in contact with the sand and gravel. In addition, in areas of the Main Plant, the silt and clay unit has been breached by utility excavations.

The alluvial deposits are thickest in the southern portion of the site and thin out to the north, until only residual soils are encountered. These relations are illustrated in Figure 26.

The manmade fill consists of crushed stone, earthen fill, construction rubble, and wastes. The thickness of the manmade fill in the manufacturing area is 2 to 4 feet and comprises mostly earthen fill and construction rubble. This material has not been compacted and, generally, has a high porosity. In the West Yard the thickness of the manmade fill is generally larger and includes extensive areas of waste disposal.

7.1 Bedrock Aquifer System

The water bearing unit for the bedrock aquifer is the Passaic Formation, often referred to as the Brunswick Shale. This is a semi-confined aquifer, separated from the overlying sediment sequence by a low-permeability unit of silt and clay that is up to 5-feet thick and comprised of the residual soil and alluvial bottom silt and clay (where it exists). Observations made during drilling indicate that the uppermost 5 to 10 feet of the bedrock are unsaturated.

The primary porosity of the rock is low. However, faulting, jointing, and bedding parallel parting give rise to secondary porosity that is significant. Wells that intersect zones that are highly fractured can provide yields of hundreds of gallons per minute.

Previous investigations have identified three zones of highly fractured bedrock which are referred to as "the SS transmissive zone", "the highly transmissive zone", and "the moderately transmissive" zone (Figure 27). These zones trend northeast-southwest and dip to the northwest at approximately 9 degrees. This coincides with the orientation of the bedding of the Passaic Formation. They are reported as either zones of well developed bedding parallel parting or layers of intensely jointed rock.

Pump test data from previous hydrogeologic investigations indicate the horizontal permeability of the uppermost 100 to 200 feet of bedrock ranges from $1\text{E-}4$ to $1\text{E-}6$ ft/min. The average permeability of the transmissive units is $1\text{E-}4$ ft/min, while the low transmissivity zones range from $1\text{E-}5$ to $1\text{E-}6$ ft/min.

Under natural conditions, ground-water from the bedrock aquifer is expected to discharge to the Raritan River. However, three production wells are in operation on site and create a cone of depression that governs the direction of ground-water flow in the bedrock. Due to this pumpage, water flows from the perimeter of the site inward towards the pumping wells (Figure 28). This is also indicated by the water level measurements collected in the shallow bedrock piezometers.

Based on data from multiple level bedrock wells, vertical downward gradients range from 0.094 to 0.001. These gradients are indicative of the conditions existing in the uppermost 150 feet of the bedrock aquifer. The gradients are steeper in the northern part of the site, due to the influence of the pumping wells.

7.2 Overburden Aquifer System

The overburden aquifer system comprises two water producing/ water transmitting units: the sand and gravel, which volumetrically is the main water producing/ water transmitting unit, and the manmade fill.

Sand and Gravel

The sand and gravel occupies the lower portion of the overburden and is separated from the manmade fill by a discontinuous unit of silt and clay. This silt and clay unit has a smaller hydraulic conductivity than the overlying and underlying units, and therefore acts as a hydraulic barrier which creates confining conditions. Where the silt and clay unit is missing, the sand and gravel acts as an unconfined aquifer.

Water level measurements from the on-site wells and piezometers indicate that although the water producing unit is the sand and gravel the static water level is recorded 2 to 4 feet above the contact with the overlying low-permeability silts and clays, suggesting that confined conditions exist.

The horizontal component of ground-water flow exhibits a divergent pattern (Figure 29). Generally, a ground-water divide is defined by a line connecting the Lagoon 5 Complex with the northeastern corner of the Main Plant area. North of the divide, ground-water flows to the north, and south of the divide ground-water flows to the south. This is due partially to:

1. The configuration of the confining clay unit, which is missing along the central and northern portion of the manufacturing area, creating a low pressure discharge area; and
2. A bedrock high occupying the northern terminus of the site, on which the sand and gravel on-laps. The area of on-lap coincides with the transmissive zones of the bedrock aquifer and is influenced by pumping the on-site production wells.

The southerly flow is controlled by the thickness and composition of the sand and gravel unit. It is expected that the flow will be greatest along the deepest parts of the buried valleys, where the sand and gravel is thickest and coarsest.

Pump test data collected during previous investigations from the vicinity of the Lagoon 8 Complex indicate that a hydraulic connection between Cuckolds Brook and the overburden aquifer system may exist in that area. This is manifested as an increase in transmissivity with time, as the zone of influence of the pumping well extends beneath the brook. This is due to the

fact that the northern course of Cuckolds Brook is bedded into the bedrock, which in the northern portion of the site acts a discharge area for the sand and gravel water bearing unit. Therefore, under pumping conditions, Cuckolds Brook behaves as a losing stream. However, under equilibrium (non-pumping) conditions, the potentiometric surfaces elevation contours indicate that the horizontal ground-water flow direction is away from the brook. Downstream of the Lagoon 5 Complex, Cuckolds Brook is bedded in the silt and clay unit. Data from the still well indicate that the water surface of the brook is approximately 2 feet higher than the potentiometric surface of the sand and gravel water bearing unit. Based on these two observations it is expected that the brook will be hydraulically separated from the sand and gravel water bearing unit.

Two methods were employed in estimating the permeability of the sand and gravel unit: comparison of the site soils grain size distribution curves to reference curves of known permeability; and slug testing of the Main Plant piezometers.

To estimate the permeability of the sand and gravel, the grain-size distribution curves of the site sand and gravel samples (presented in Appendix A-6 of the Soils RI Report/FS Work Plan) were compared to published curves (Figure 30). Based on that comparison, a theoretical permeability value of $1.4E-1$ ft/min was estimated. However, the reference curves do not extend into the silt and clay range, which comprises approximately 10 to 20 percent of each sample collected from the sand and gravel unit. To account for this, Hazen's approximation was applied to the data. Hazen's approximation states that the ratio of the permeabilities of two

materials is proportional to the square of their effective grain size (i.e., the 90 percent retained size). The effective grain size of the reference curve is 40/1000-inch and the effective grain size of most site samples is 2/1000-inch. Therefore, the theoretical permeability of the site sand and gravel will be $((40/1000)/(2/1000))^2$ or 400 times smaller than that of the reference curve, approximately $3.5E-4$ ft/min.

Permeability values were also estimated by slug testing (see Section 5.3). Permeability values obtained by the Bouwer and Rice method are generally reliable and in overall agreement with the permeability values calculated based on the grain size distribution curves. A tabulation of the calculated permeability values is presented on Table 2 of this attachment. As expected, based on the fact that the sand and gravel unit possesses an upwards fining trend, the permeabilities calculated from the intermediate piezometer data are generally lower than the permeabilities calculated from the deep piezometer data. The average estimated permeability based on slug test data is $7.05E-3$ ft/min.

Man-made Fill

The manmade fill occupies the uppermost 2 to 4 feet of the Main Plant area soils and overlies the silt and clay unit creating localized perched water table conditions. Ground water in the fill occurs 6 to 18 inches below ground surface.

Based on water elevation measurements collected from the water table piezometers, the horizontal ground-water flow direction converges towards the area between Cuckolds Brook and Lagoon 1 Complex (Figure 30). This convergence is attributed to the fact that the banks of Cuckolds Brook

consist of material that, based on visual examination, appears to be fine grained (probably engineered fill) and of lower permeability than the manmade fill unit, which consists of crushed stone, rubble, and waste. Furthermore, the manmade fill is in contact with the sand and gravel in the discharge area, which acts as a zone of elevated transmissivity due to its greater aggregate thickness and permeability.

Vertical Gradients

Based on ground-water elevation measurements collected from the on-site piezometers, the vertical component of ground-water flow between the manmade fill and the sand and gravel is downward. The gradient is strongest where the silt and clay unit is present, and becomes weaker where the silt and clay unit is missing, due to uninhibited discharge from the manmade fill to the sand and gravel unit.

The vertical gradient between the sand and gravel and the shallow bedrock aquifer is slight, as the static water levels in the two units are approximately equal. The subcrops of the bedrock transmissive zones do not exert a marked influence on the vertical gradients.

TABLE 1
AMERICAN CYANAMID
MAIN PLANT PIEZOMETERS
GROUND-WATER ELEVATIONS

<u>PIEZOMETER</u>	<u>8/6/90</u>	<u>8/7/90</u>	<u>DATE</u> <u>8/8/90</u>	<u>8/13/90</u>	<u>8/21/90</u>
PZ-1WT	101.73	101.61	101.76	101.69	101.79
PZ-1I	96.77	97.98	97.78	98.40	98.34
PZ-1D	96.16	97.45	97.70	98.43	98.38
PZ-1R	96.16	96.68	96.85	97.50	97.27
PZ-2WT	99.55	100.04	100.01	100.15	99.65
PZ-2I	98.51	95.98	98.83	99.15	96.31
PZ-2D	98.15	99.15	95.89	96.48	96.03
PZ-3WT	102.41	102.77	102.57	102.79	102.50
PZ-3R	94.36	94.55	95.67	95.42	95.37
PZ-4WT	98.51	99.64	99.96	99.48	98.72
PZ-4I	96.32	96.57	96.80	97.42	96.80
PZ-4D	96.15	96.30	96.65	97.11	93.80
PZ-5WT	100.43	100.54	100.15	100.26	99.97
PZ-5I	95.23	94.84	95.09	95.66	95.55
PZ-5D	93.96	94.94	95.08	95.00	95.56
PZ-5R	93.53	94.56	94.95	95.40	95.28
PZ-6WT	107.24	107.76	107.57	107.64	107.06
PZ-6R	93.22	94.02	94.30	93.27	95.22
PZ-7WT	97.66	94.49	98.39	98.12	97.91
PZ-7D	94.95	94.37	94.85	95.83	95.52
PZ-8WT	98.58	99.22	99.29	98.86	98.80
PZ-8I	94.96	95.70	95.93	96.38	96.37
PZ-8D	97.99	95.31	95.48	95.90	95.59
PZ-8R	95.11	95.46	95.36	96.11	95.87
PZ-9WT	95.22	95.39	95.56	95.91	95.65
PZ-9D	95.11	95.57	95.70	95.97	95.59
PZ-9R	95.09	95.20	94.15	95.65	95.51
PZ10-WT	97.95	100.62	99.89	99.83	99.91
PZ-10I	95.08	95.57	98.94	96.34	95.83
PZ-10D	95.13	95.61	95.87	96.88	95.73
PZ-11WT	96.33	96.63	97.22	98.44	97.21
PZ-11D	95.18	95.52	95.66	96.28	95.64
PZ-11R	95.77	88.56	95.80	95.45	95.53

Note: Ground-water elevations are referenced to American Cyanamid datum.

TABLE 2
HORIZONTAL PERMEABILITY VALUES
CALCULATED FROM SLUG TESTS

<u>PIEZOMETER</u>	<u>HYDRAULIC CONDUCTIVITY</u>
PZ-1D	1.93E-2ft/min
PZ-2I	2.69E-3ft/min
PZ-2D	4.68E-3ft/min
PZ-4I	2.15E-3ft/min
PZ-4D	4.01E-3ft/min
PZ-5I	6.95E-3ft/min
PZ-5D	9.25E-3ft/min
PZ-7D	2.31E-3ft/min
PZ-8I	7.63E-3ft/min
PZ-8D	4.70E-3ft/min
PZ-9D	6.36E-3ft/min
PZ-10I	8.97E-3ft/min
PZ-10D	1.29E-2ft/min
PZ-11D	6.70E-3ft/min

Note: Permeability values calculated by the Bouwer and Rise method.

FOR FIGURE 1 OF ATTACHMENT 3
REFERENCE FIGURE 9 IN THE
TEXT OF THE SOILS RI REPORT/FS WORK PLAN

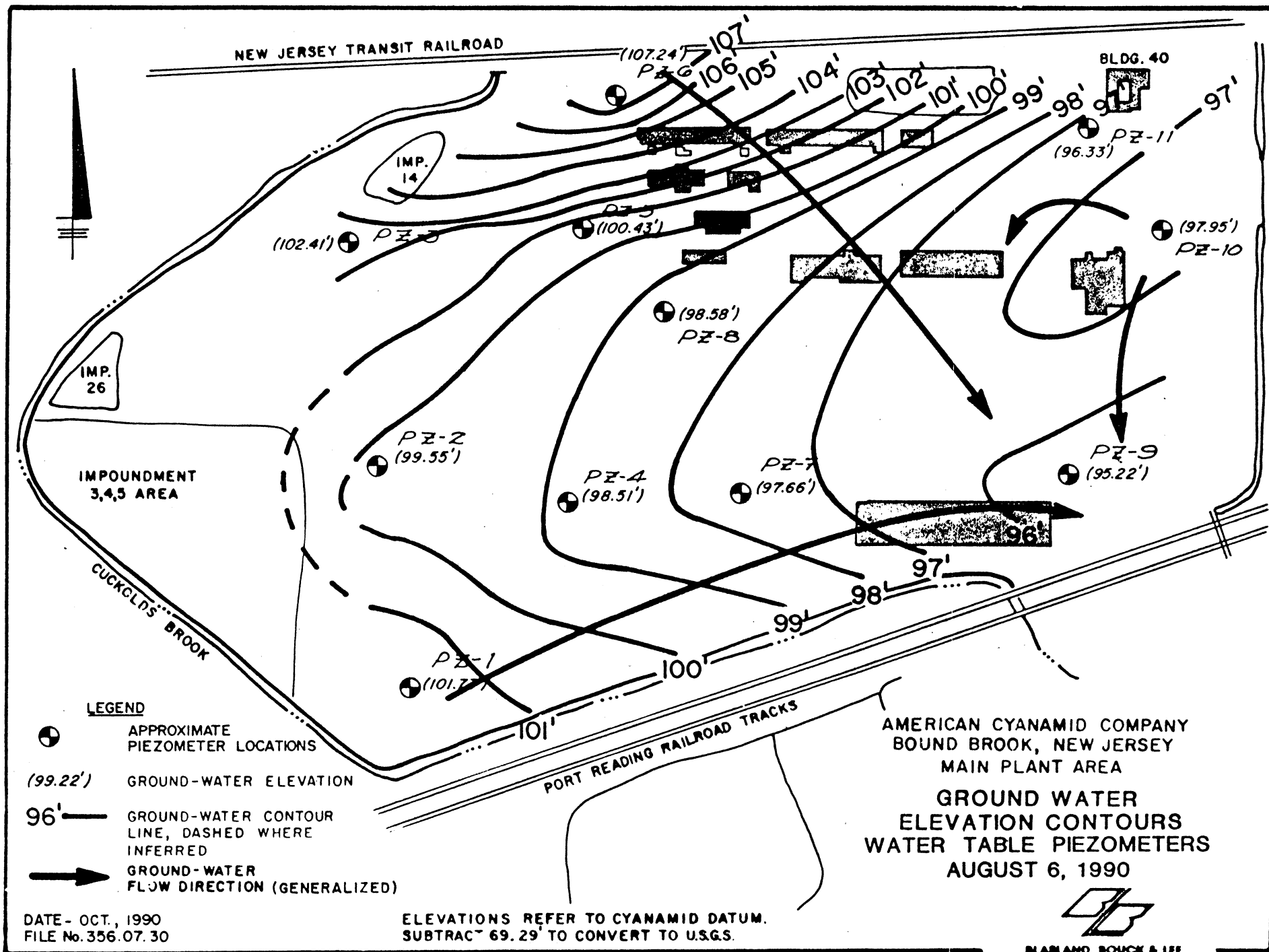


FIGURE 2

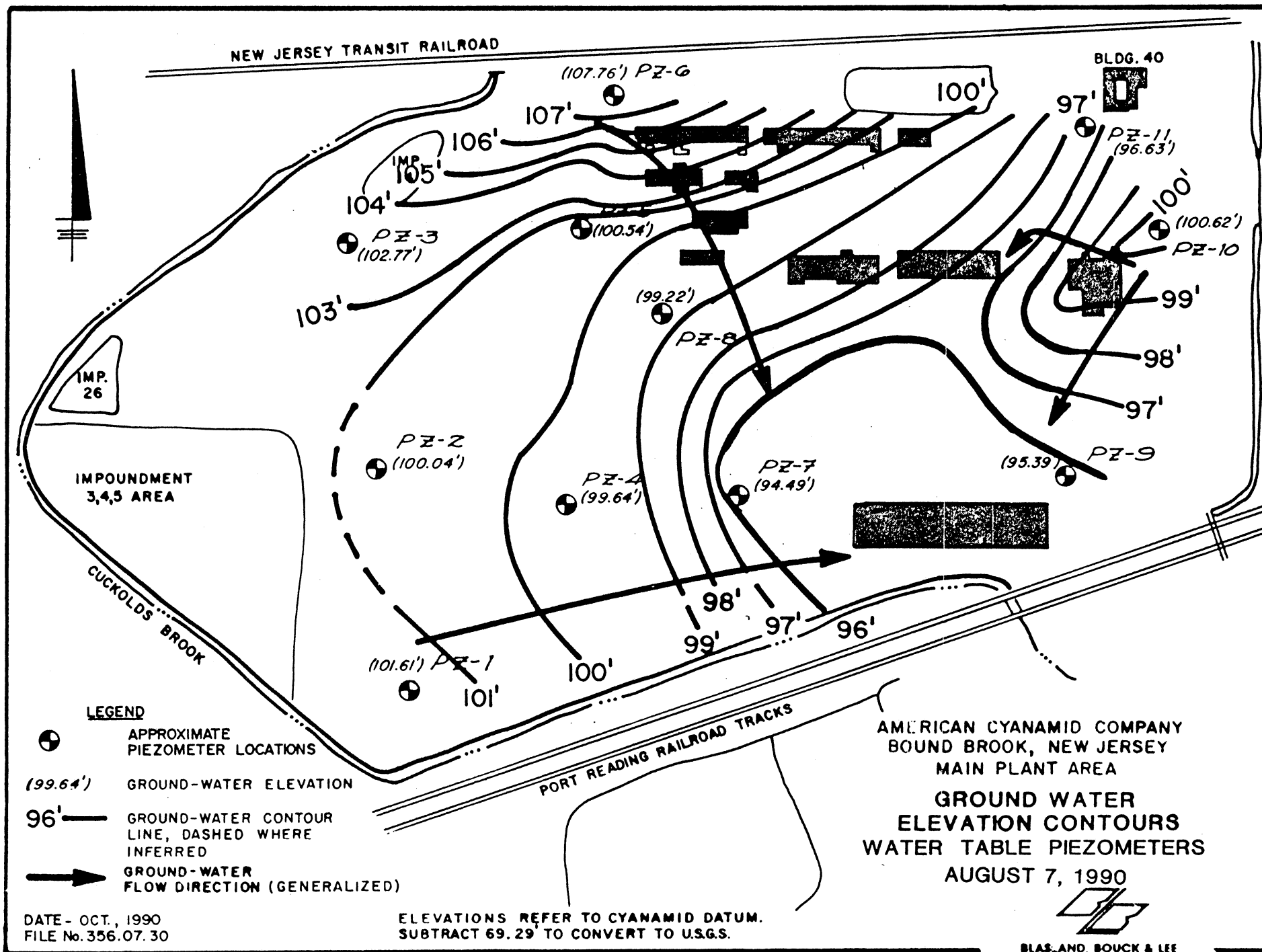


FIGURE 3

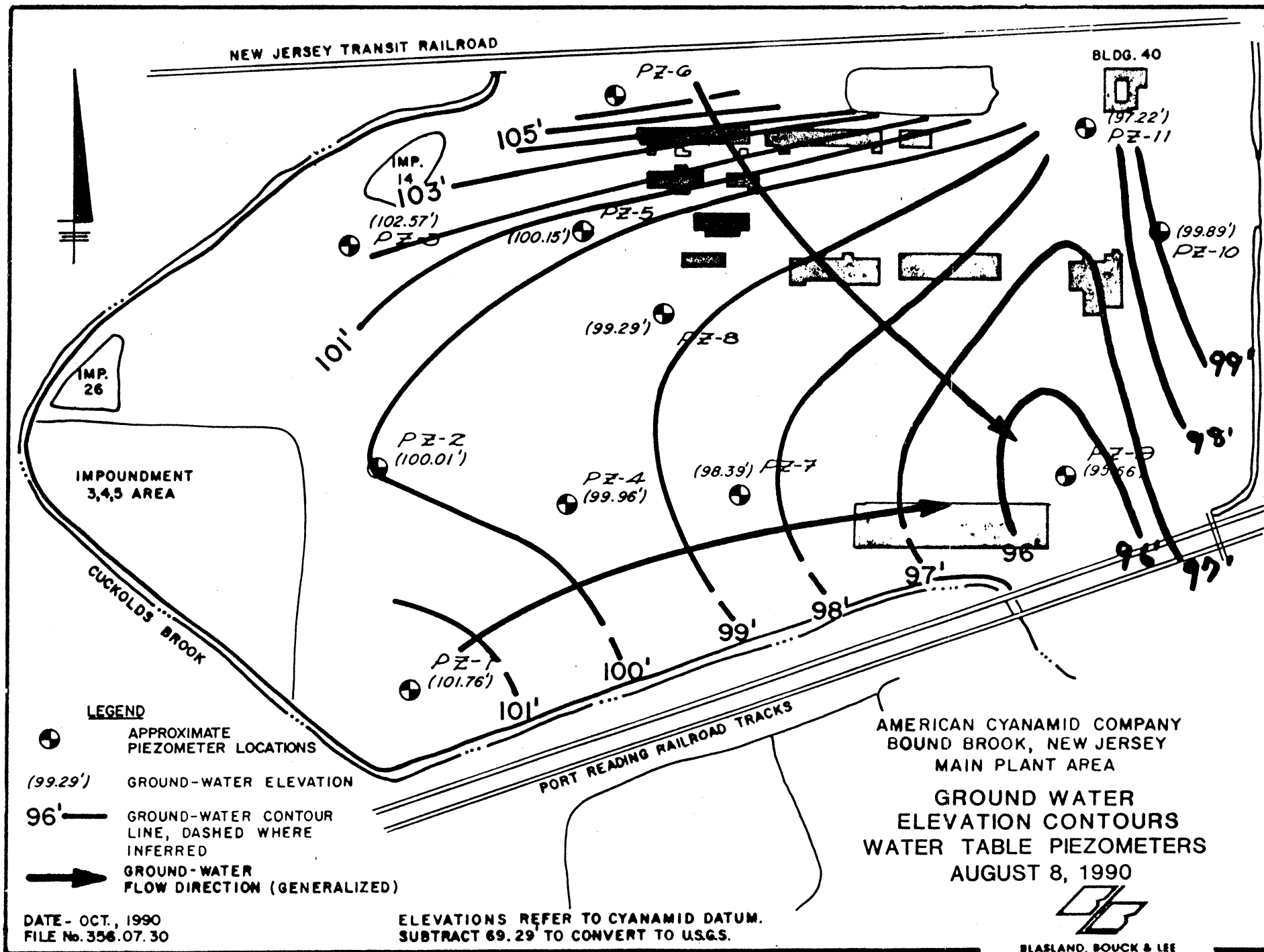


FIGURE 4

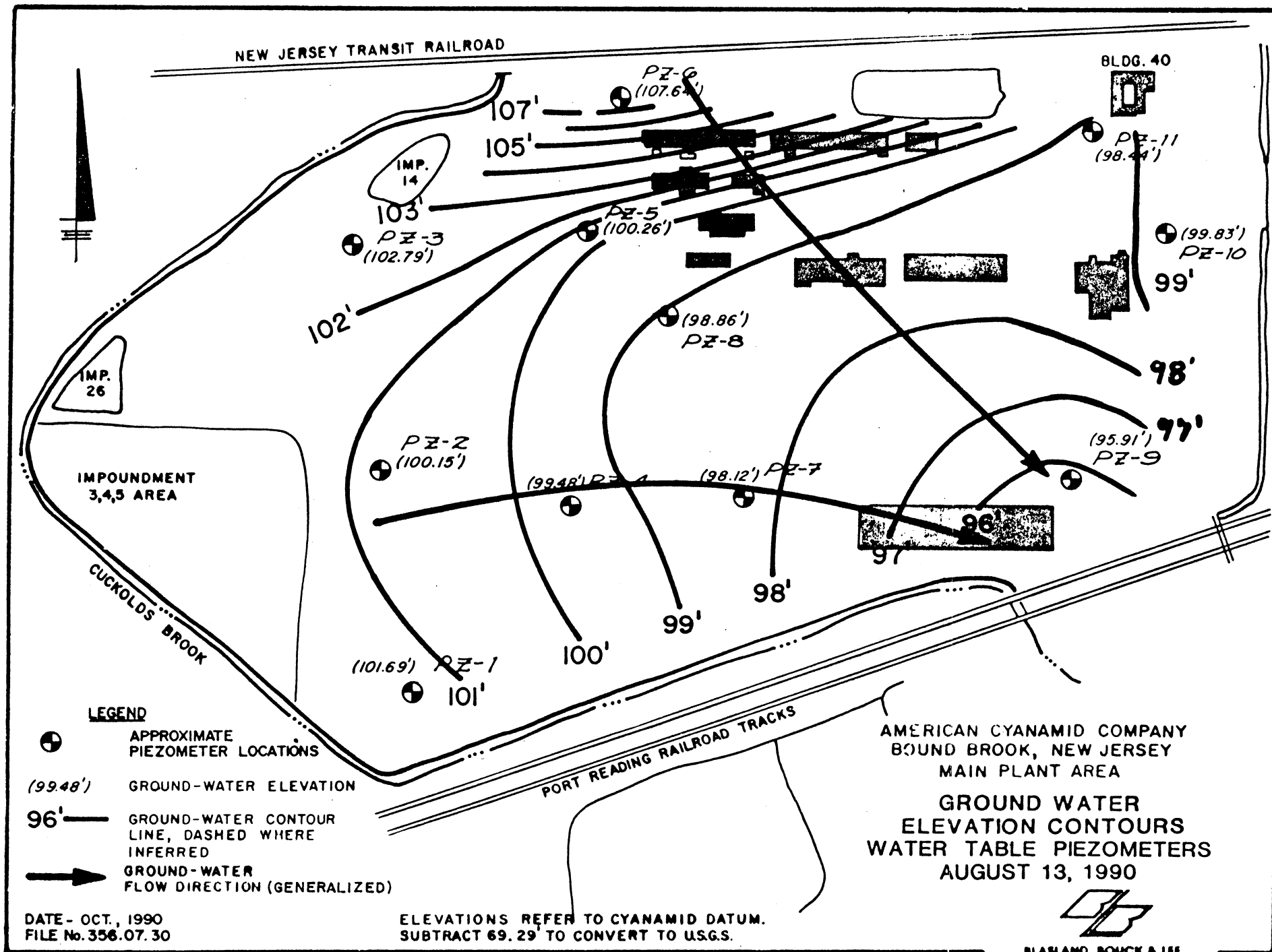


FIGURE 5

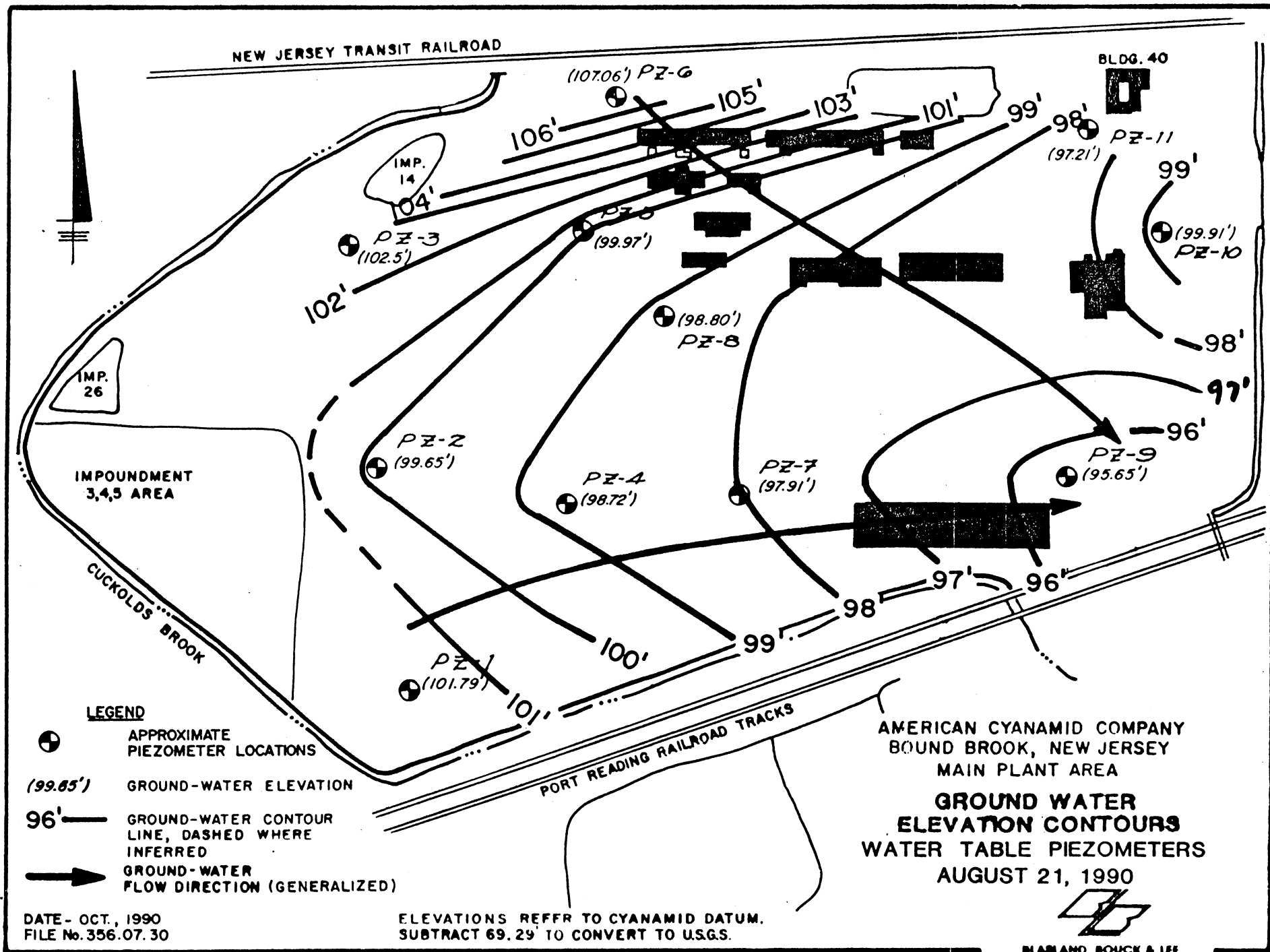


FIGURE 6

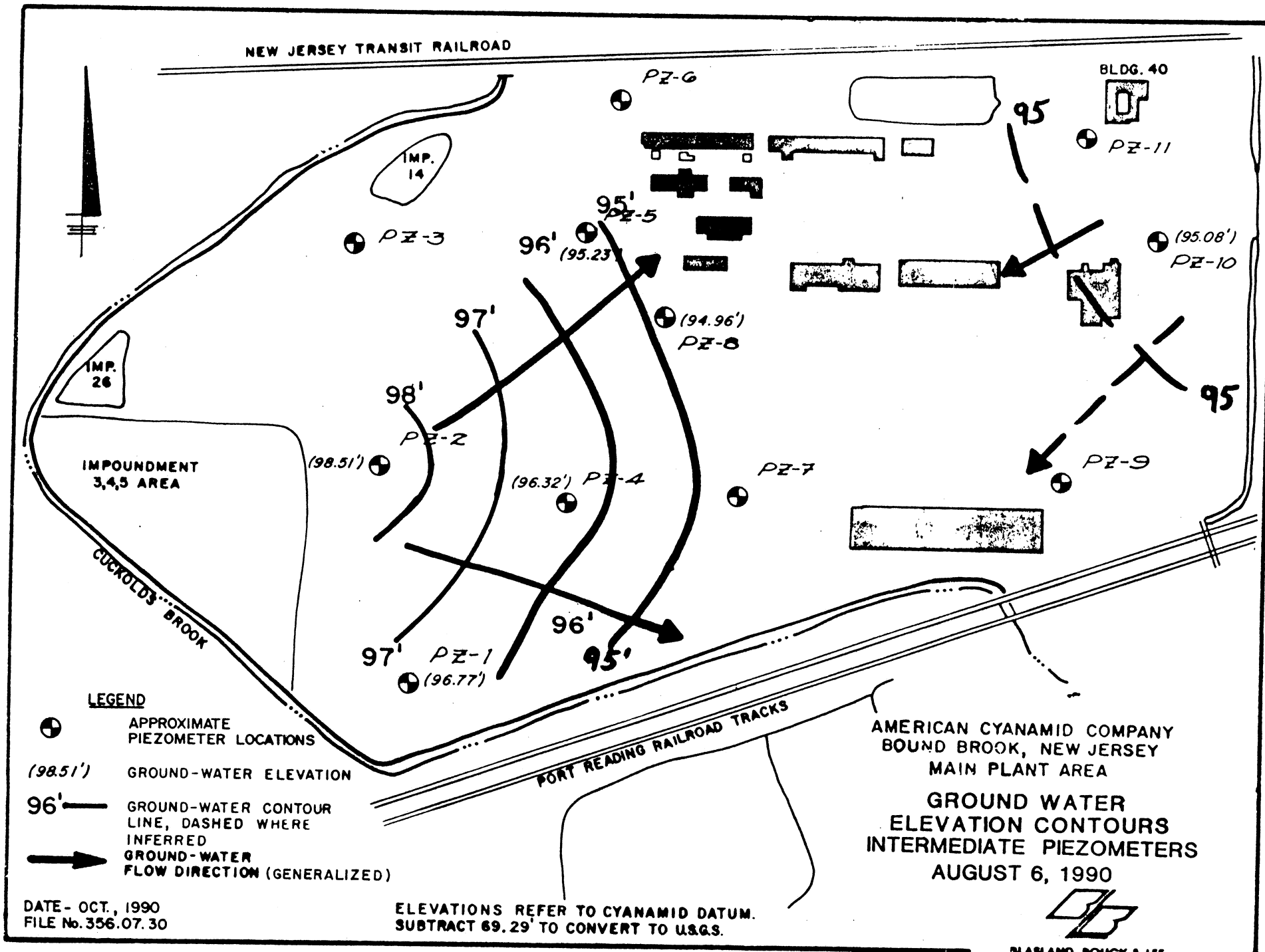


FIGURE 7

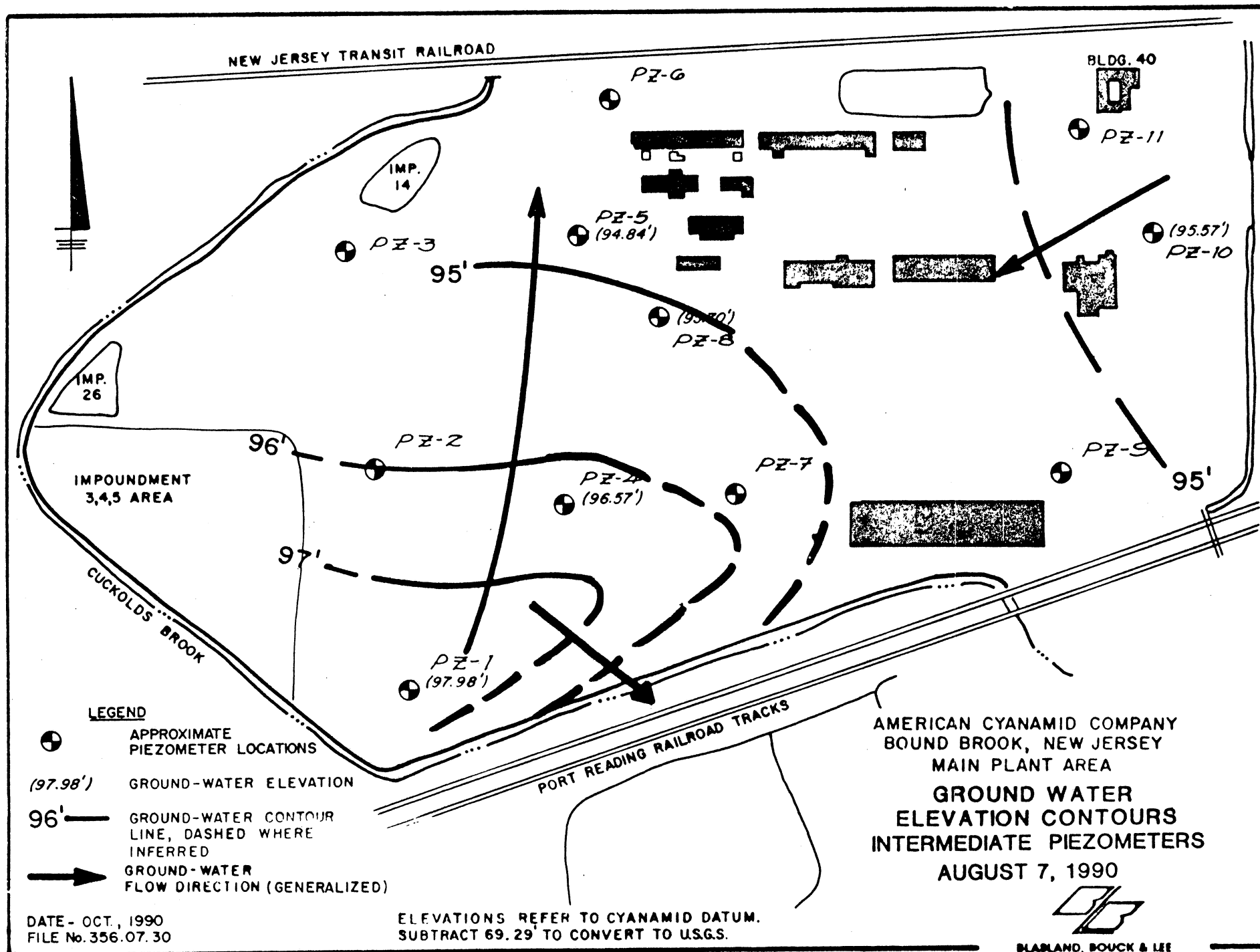


FIGURE 8

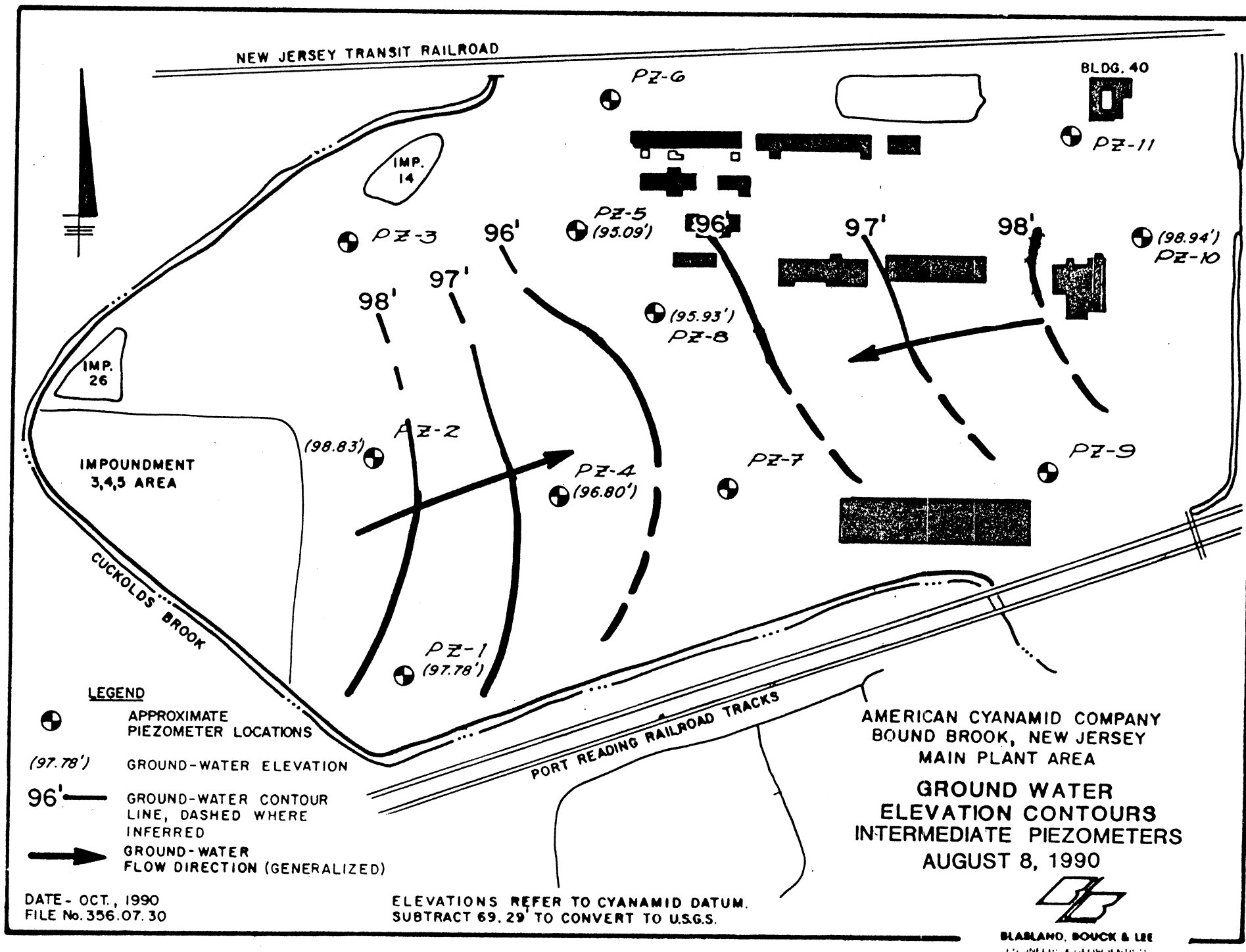


FIGURE 9

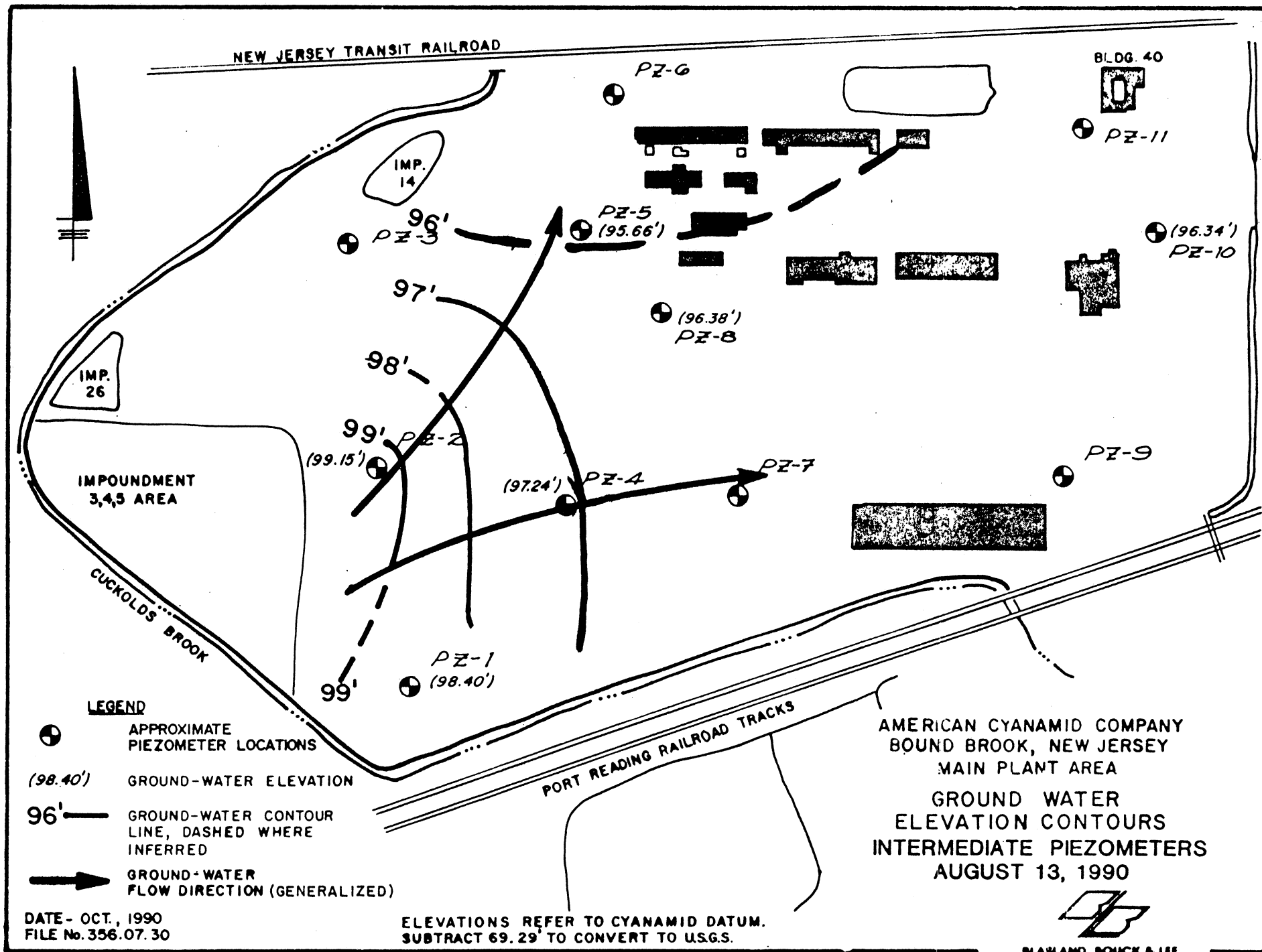


FIGURE 10

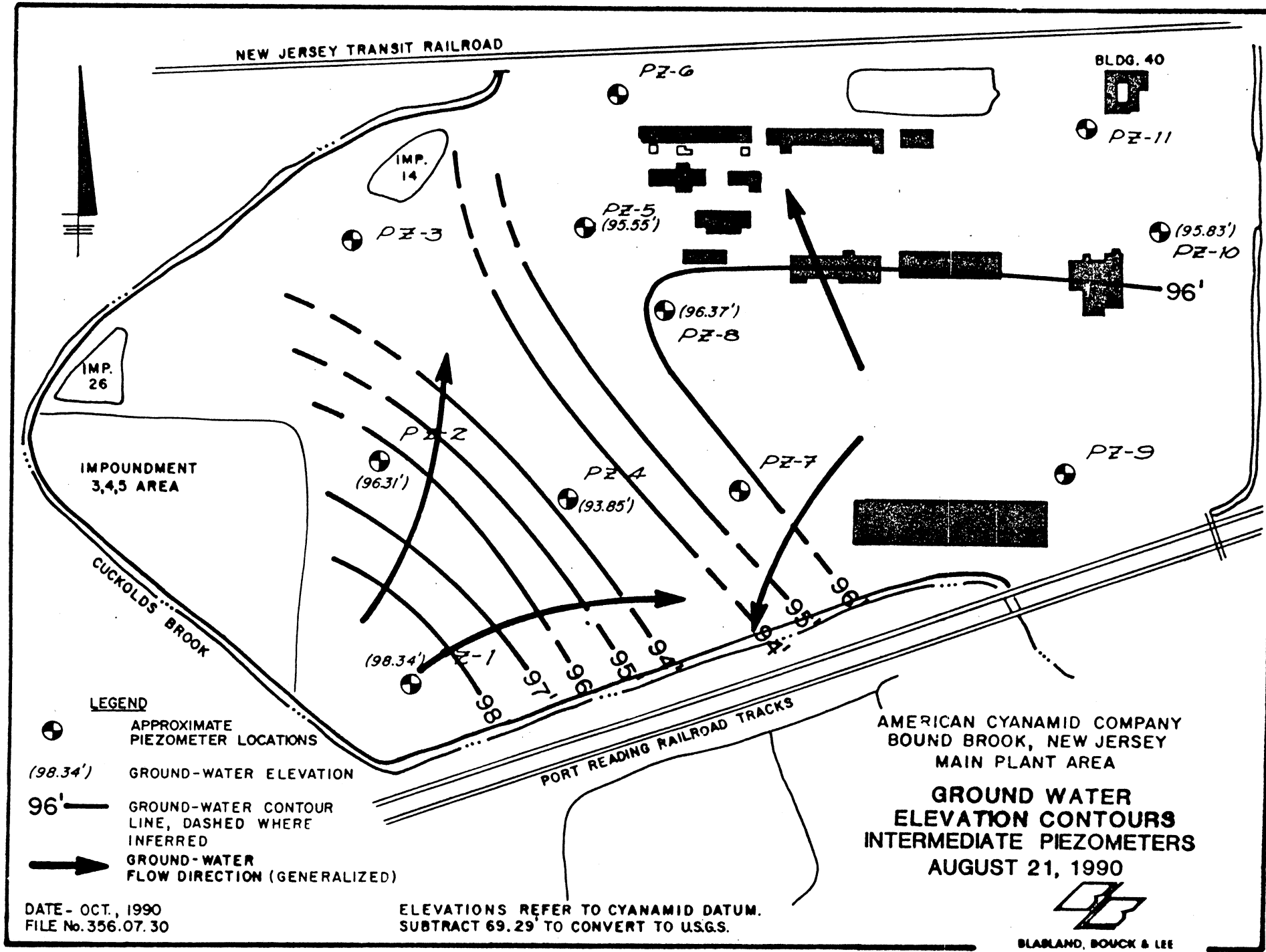


FIGURE 11

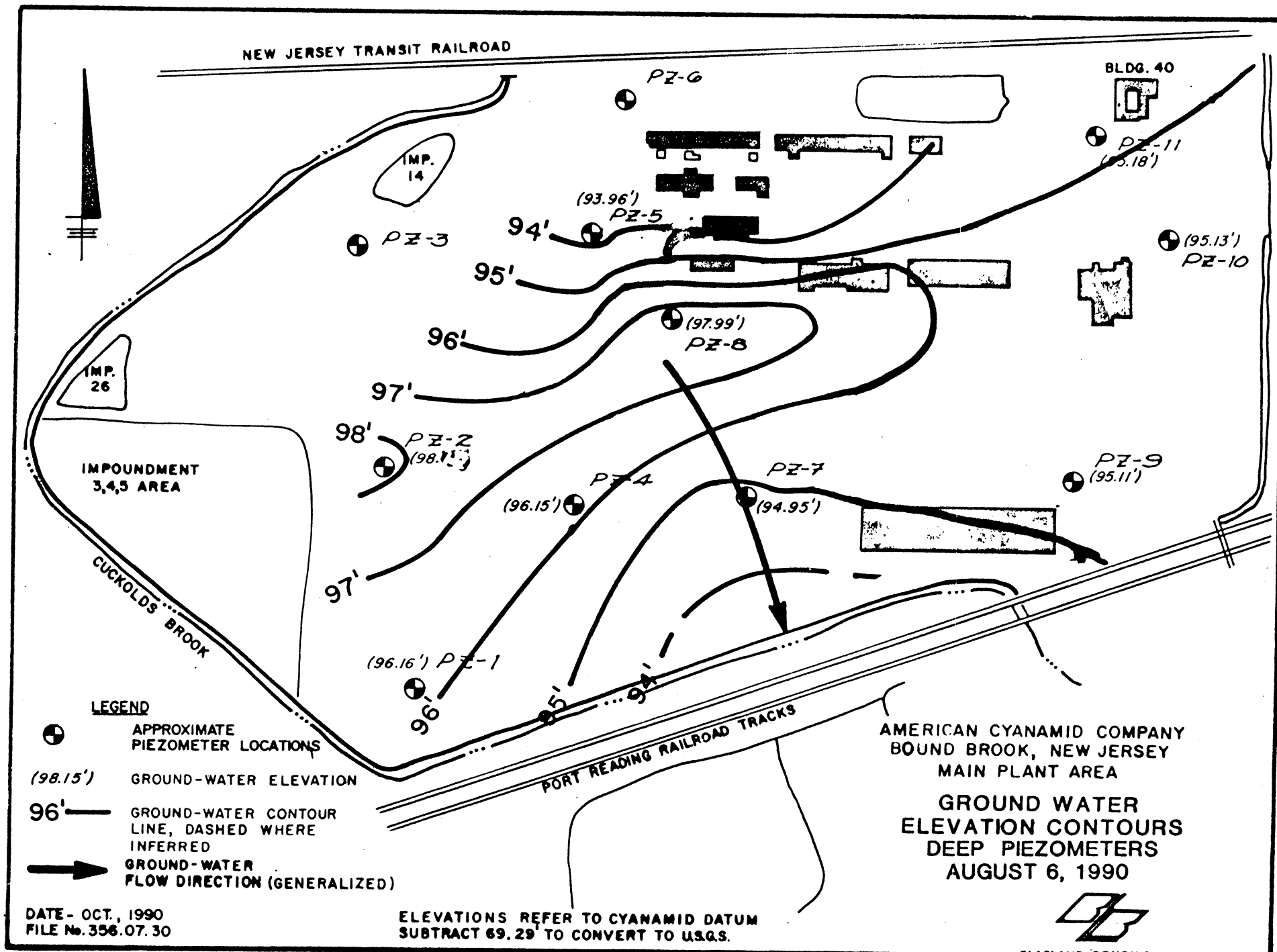


FIGURE 12

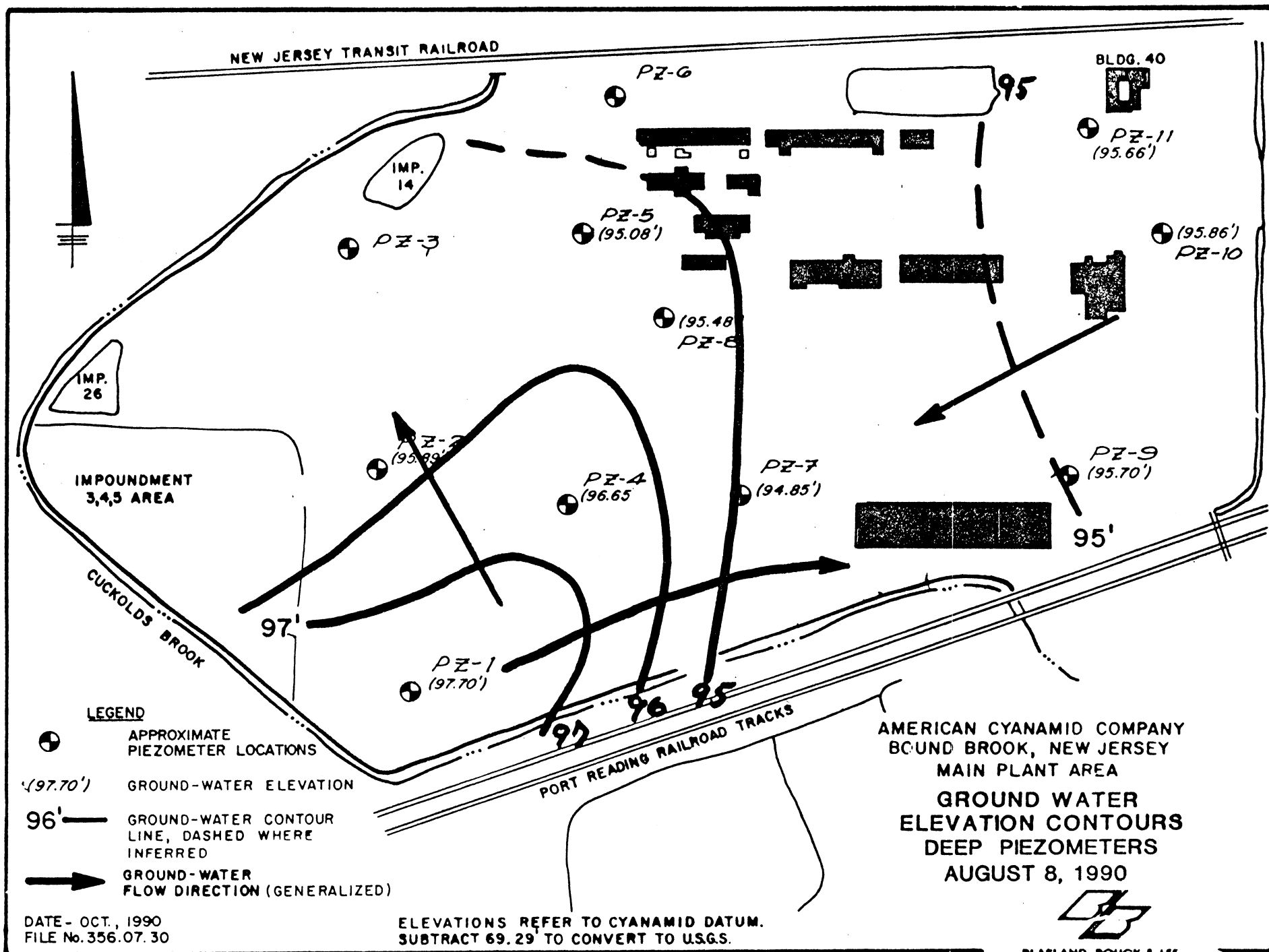


FIGURE 14

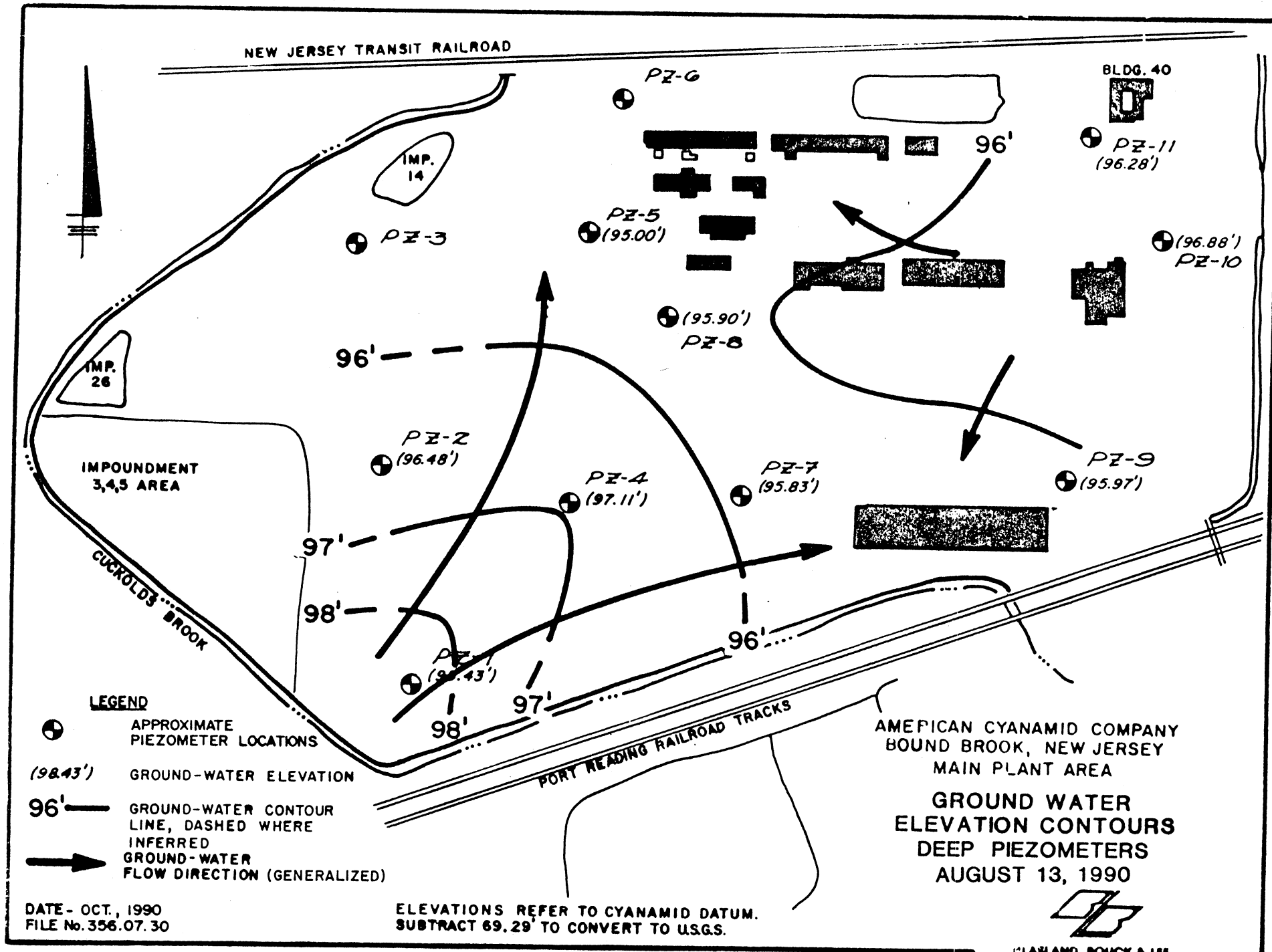


FIGURE 15

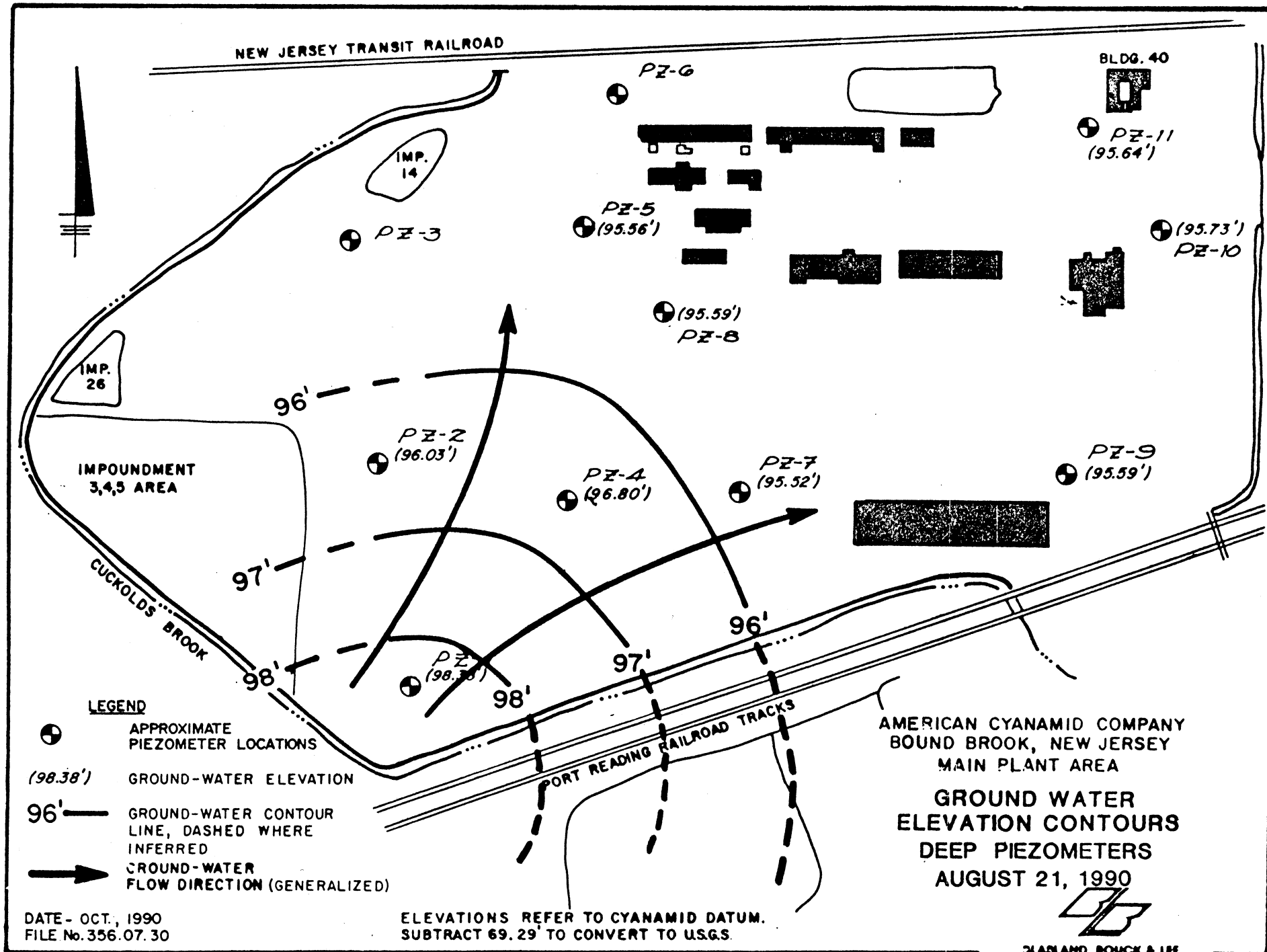


FIGURE 16

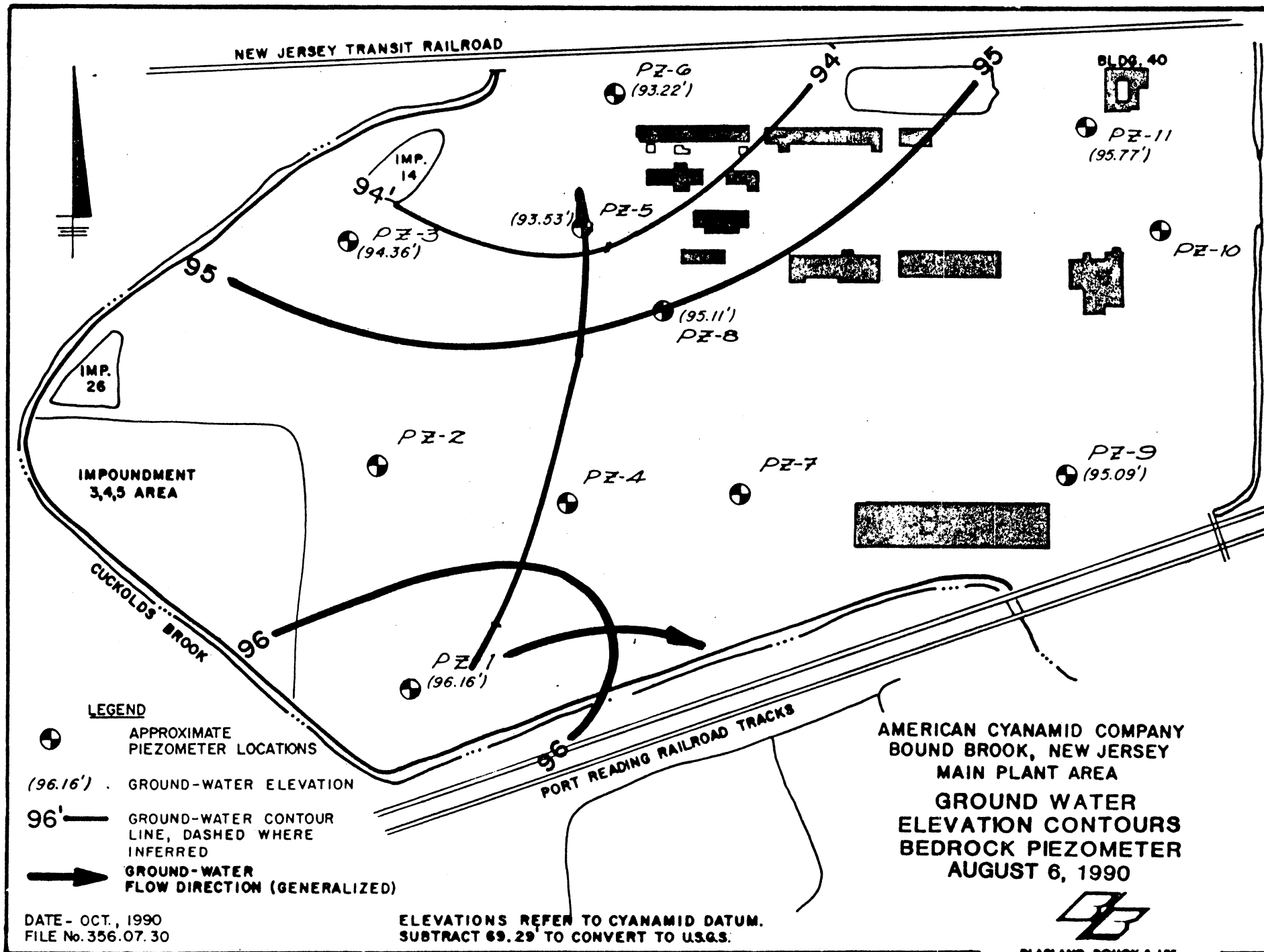


FIGURE 17

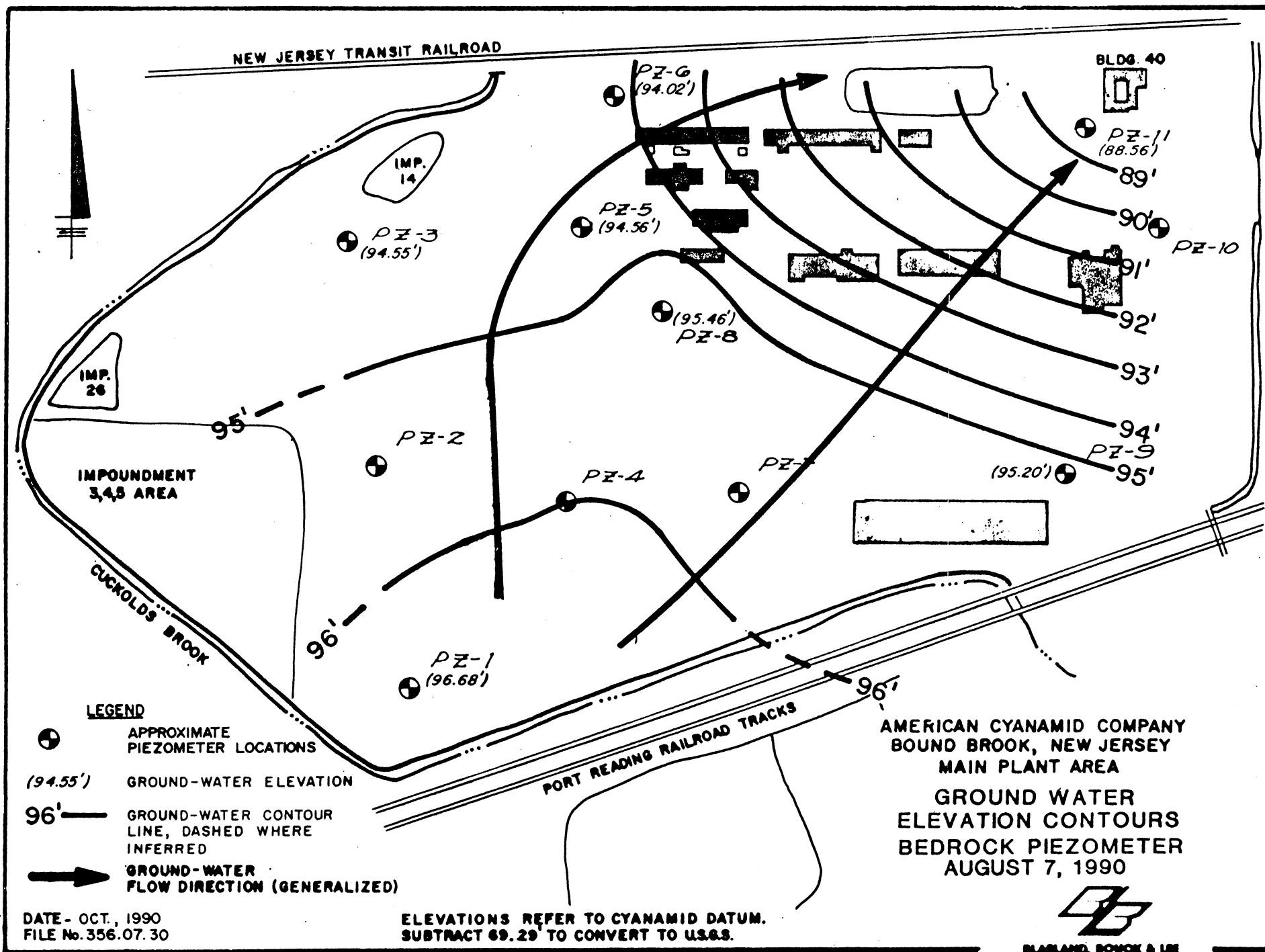


FIGURE 18

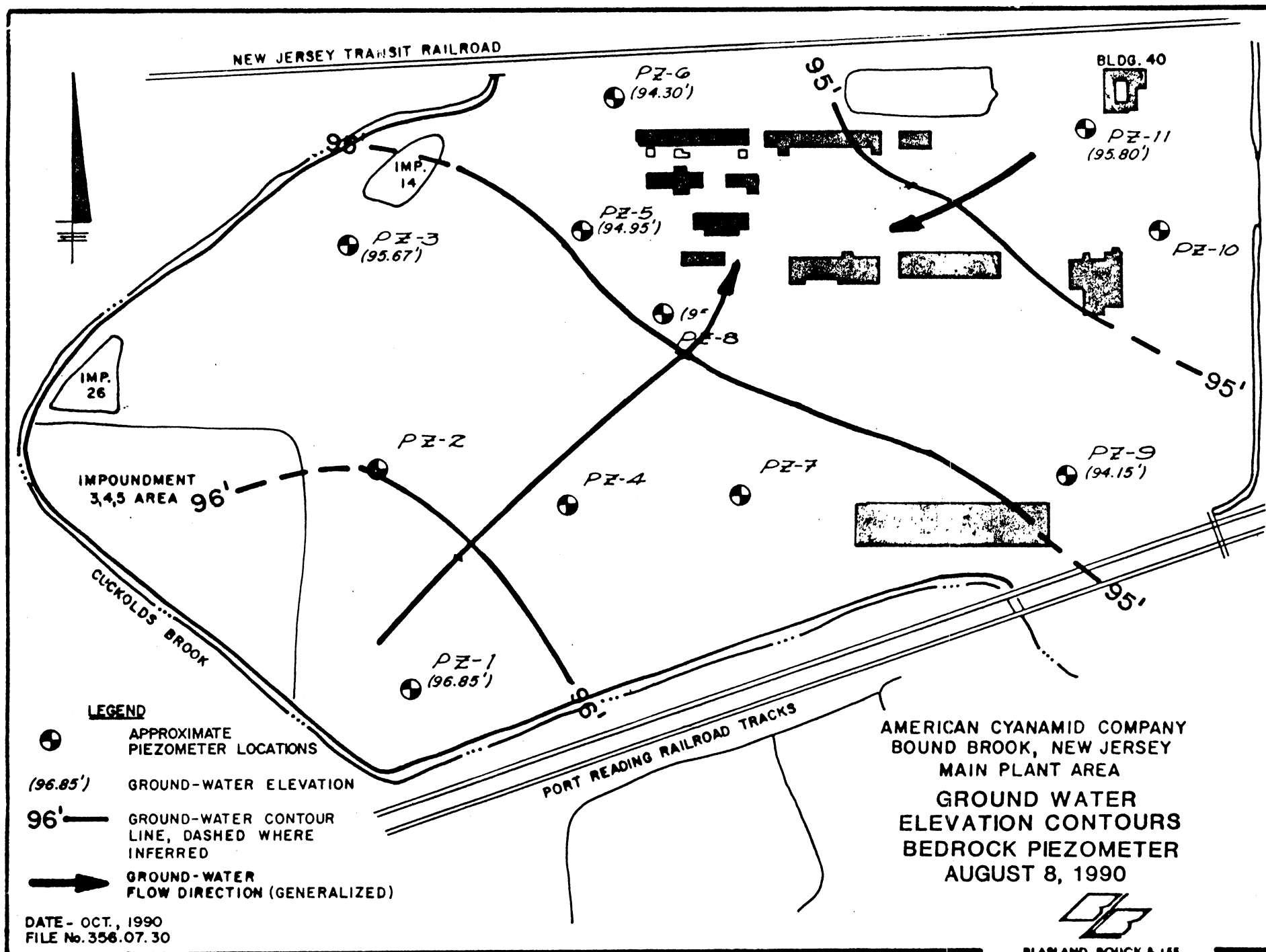


FIGURE 19

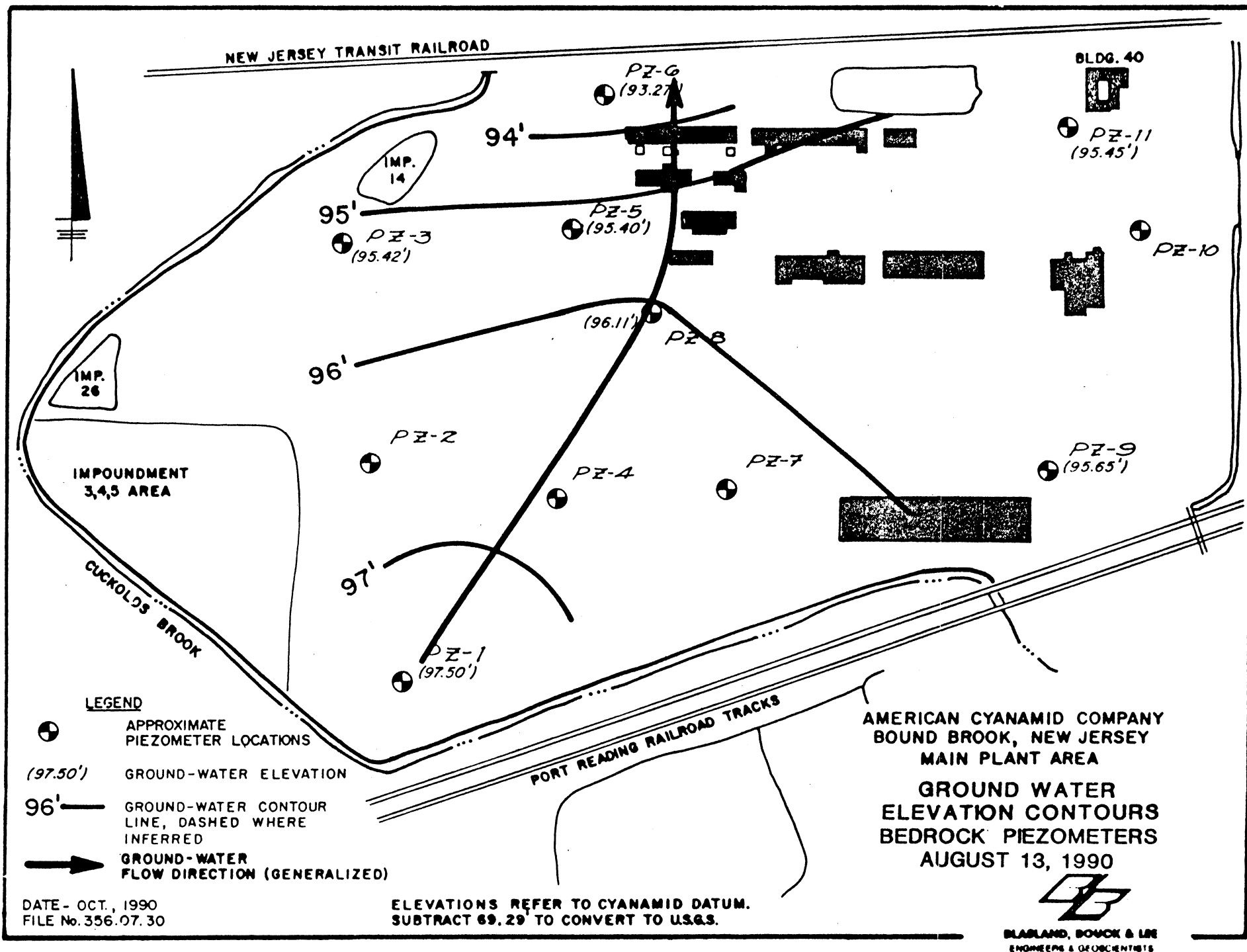


FIGURE 20

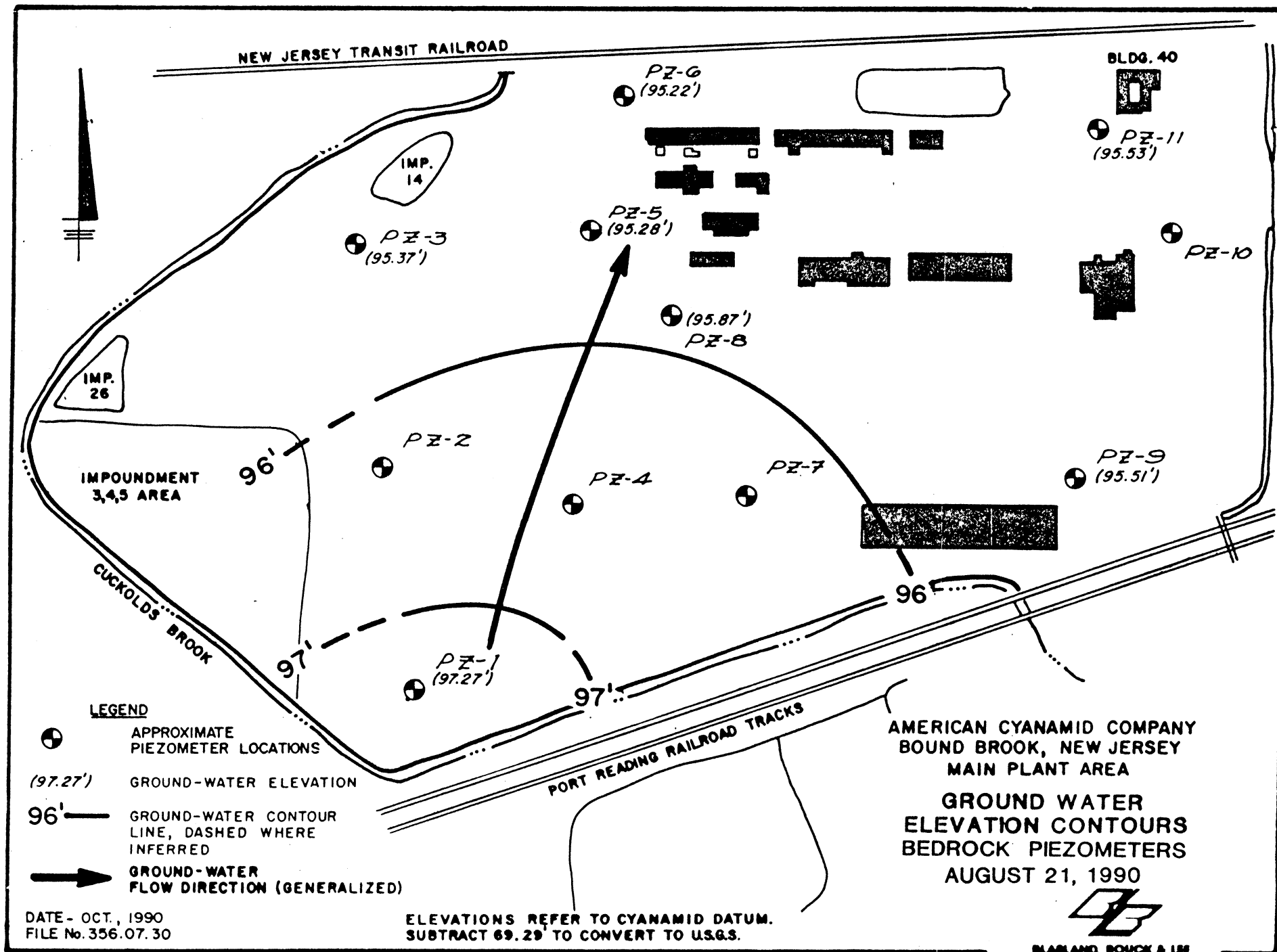


FIGURE 21

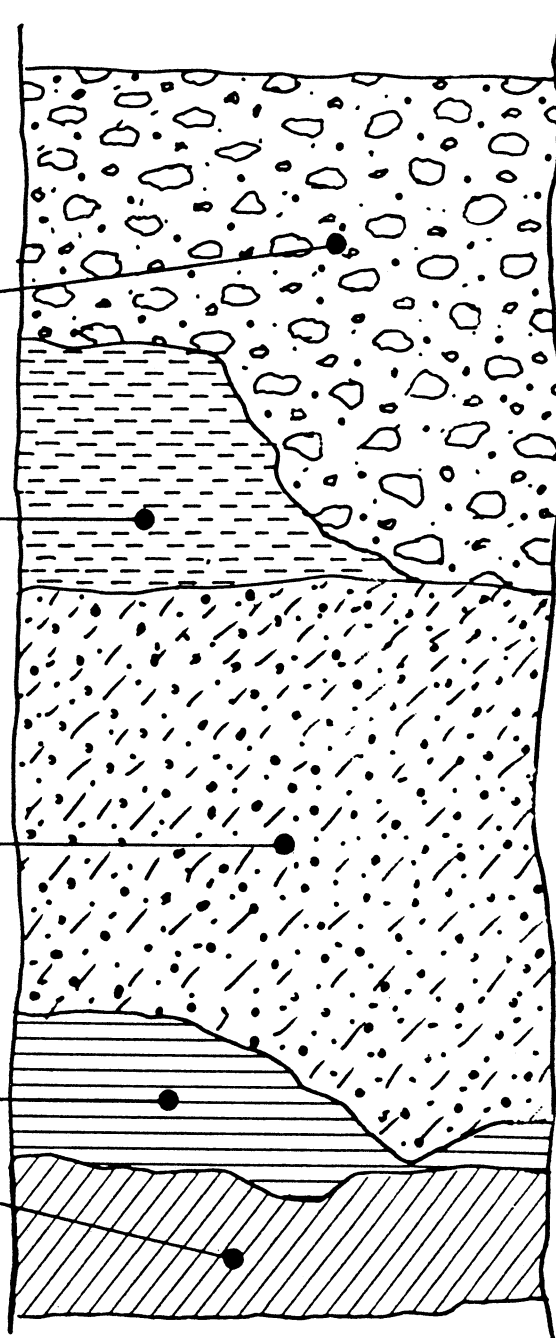
FILL and DISTURBED SOIL: Red brown SAND, SILT and GRAVEL unit ranging from 1 to 18 feet in thickness. Consists of reworked soils, demolition debris and, in areas, waste material. A perched aquifer exists within this unit when the underlying SILT and CLAY layer is present.

SILT and CLAY: An Alluvial Deposit of Grey brown and brown SILT and CLAY. Present across most of the site and typically ranges from 1 to 4 feet in thickness. In certain areas of the site (main plant) has been excavated.

SAND and GRAVEL: An Alluvial Deposit of Red brown fine to coarse SAND and fine to very coarse GRAVEL with varying amounts of SILT. This unit is present across most of the site and typically ranges from 3 to 15 feet in thickness. The major overburden aquifer of the site is within this unit. Occasionally, a silt and clay layer is present at its base.

WEATHERED SHALE: A Residual Unit of Decomposed bedrock, Red brown SILT and CLAY with a relic shale texture and shale fragments. It is present only locally and typically ranges from 0.5 to 1.5 feet in thickness when encountered. Acts as a local aquitard.

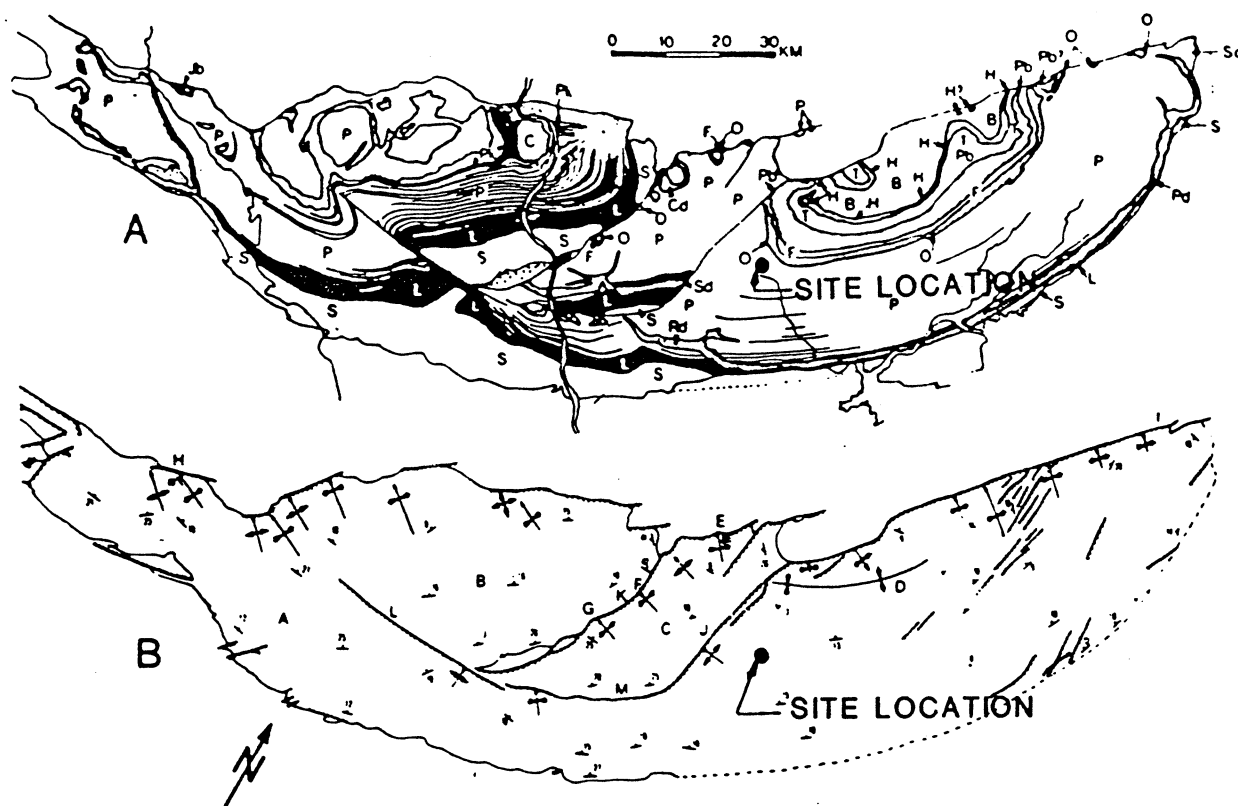
BEDROCK: Passaic Formation: Red Brown sandstone, siltstone, and claystone shale.



AMERICAN CYANAMID
BOUND BROOK, NEW JERSEY

GENERALIZED STRATIGRAPHY





The Newark Basin.

Geologic map showing distribution of formations, conglomeritic facies (irregular stipple), and major clusters of detrital cycles in Passaic Formation (parallel black lines) – abbreviations of formations and diabase bodies as follows: B, Boonton Formation; C, Coffman Hill Diabase; Cd, Cushetunk Mountain Diabase; F, Feltville Formation; H, Hook Mountain Basalt; Hd, Haycock Mountain Diabase; Jb, Jacksonwald Basalt; L, Lockatong Formation; O, Orange Mountain Basalt; P, Passaic Formation; Pb, Preakness Basalt; Pd, Palisade Diabase; Pk, Perkaskie Member of Passaic Formation; Rd, Rocky Hill Diabase; S, Stockton Formation; Sc, carbonate Facies of Stockton Formation; Sd, Sourland Mountain Diabase; T, Towaco Formation.

Structural features of the Newark Basin. Faults are all drawn as normal with dots on the down-thrown side; portions of basin margin not mapped as faults should be regarded as onlaps. While all the faults are mapped here as

normal, it is clear many, if not all of them, have some component of strike slip, although the significance of this component is unclear. Symbols for the names of structural features used in this paper are as follows: A, Montgomery-Chester fault block; B, Bucks-Hunterdon fault block; C, Sourland Mountain fault block; D, Watchung syncline; E, New Germantown syncline; F, Flemington syncline; G, Sand Brook syncline; H, Jacksonwald syncline; I, Ramapo fault; J, braided connectoin between Ramapo and Hopewell faults; K, Flemington fault; L, Chalfont fault; M, Hope II fault.

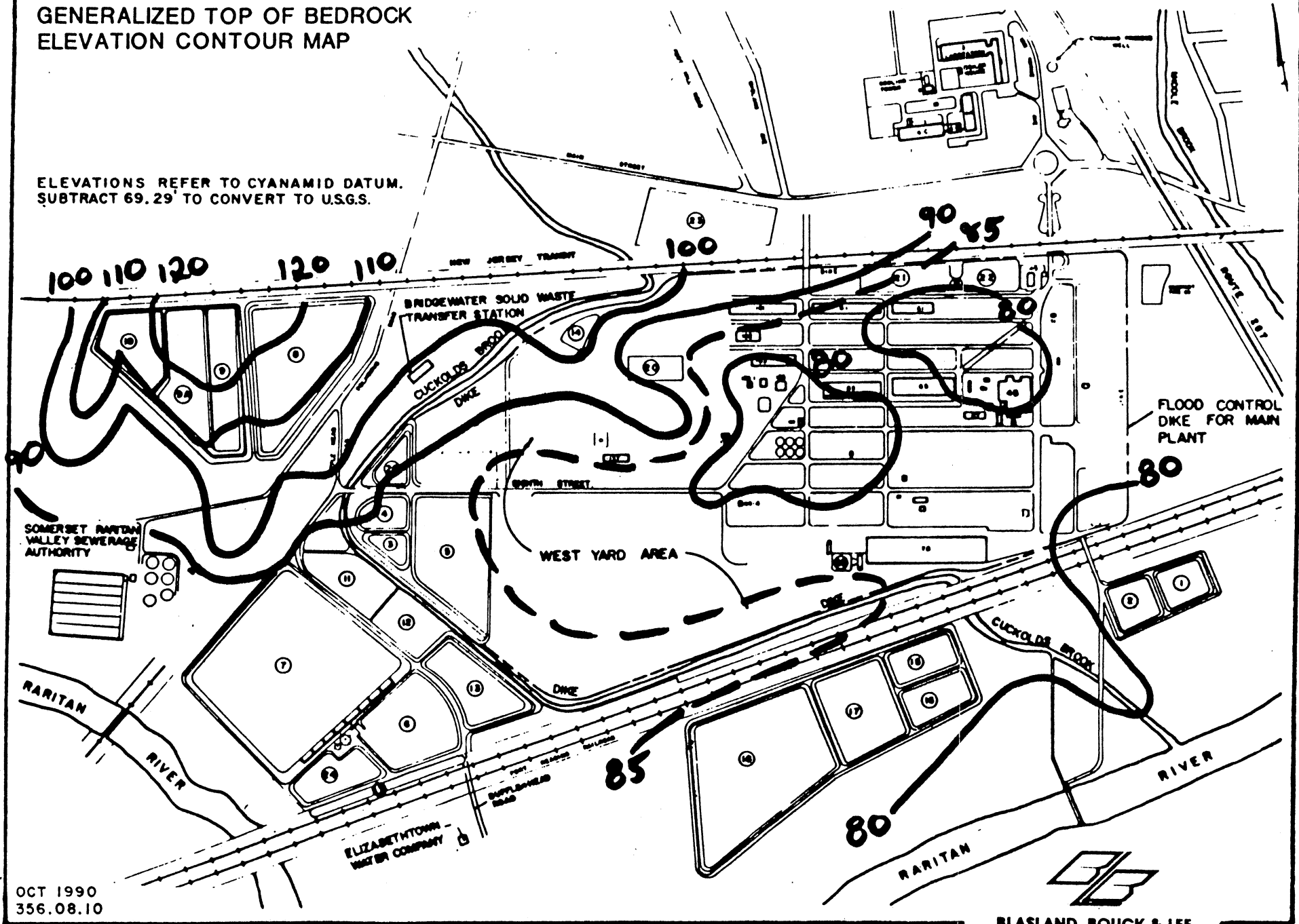
Data for A and B from Kümmel, 1897; Lewis and Kümmel, 1910-1912; Darton, 1890, 1902; Darton, et al., 1908; Glaeser, 1963; Sanders, 1962; Van Houten, 1969; McLaughlin, 1941, 1943, 1944, 1945, 1946a, 1946b; Bascom, et al., 1909; Willard, et al., 1959; Faille, 1963; Manspeizer, pers. comm.; Olsen, in press, and personal observation.

SOURCE: OLSEN (1980)

REGIONAL GEOLOGY

GENERALIZED TOP OF BEDROCK ELEVATION CONTOUR MAP

ELEVATIONS REFER TO CYANAMID DATUM.
SUBTRACT 69.29' TO CONVERT TO U.S.G.S.



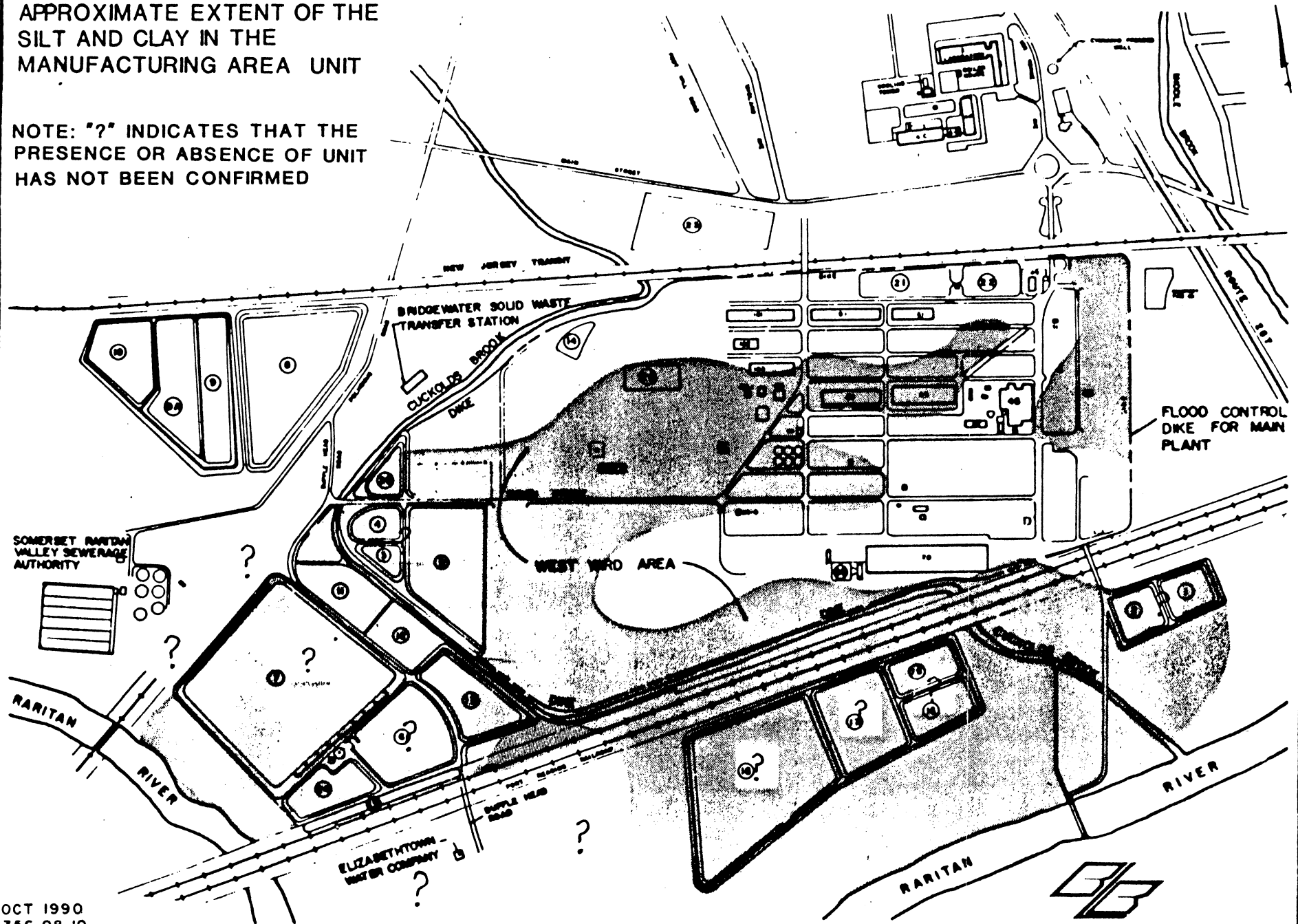
OCT 1990
356.08.10

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FIGURE 24

APPROXIMATE EXTENT OF THE
SILT AND CLAY IN THE
MANUFACTURING AREA UNIT

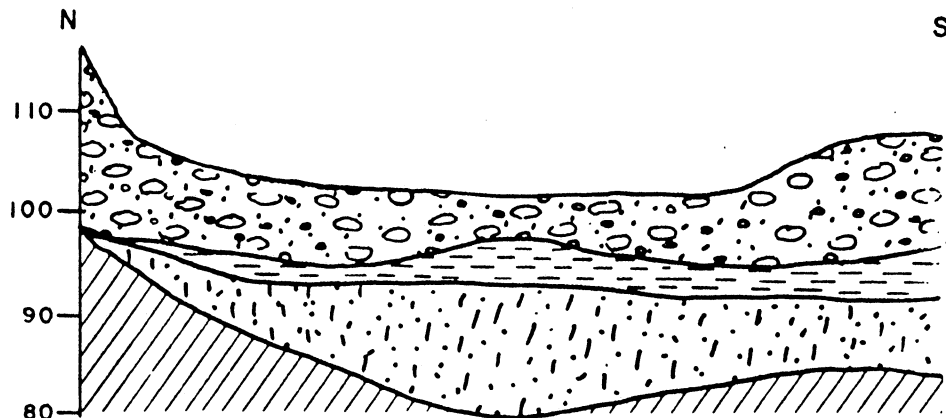
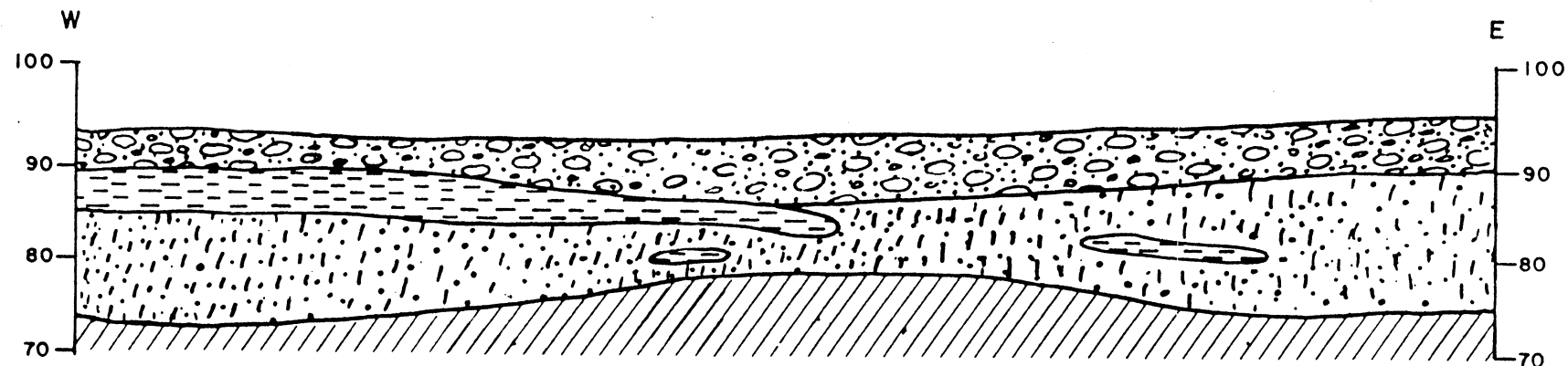
NOTE: "?" INDICATES THAT THE
PRESENCE OR ABSENCE OF UNIT
HAS NOT BEEN CONFIRMED



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FIGURE 25

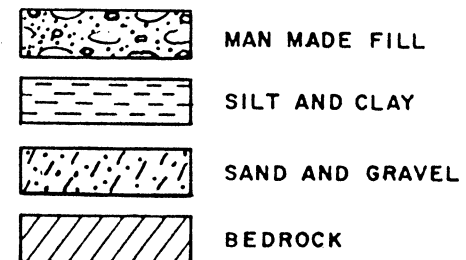


HORIZONTAL SCALE

0 250 500

FEET

LEGEND



AMERICAN CYANAMID COMPANY
BOUND BROOK, NEW JERSEY
MAIN PLANT AREA

GENERALIZED GEOLOGIC
CROSS-SECTIONS
THROUGH MAIN PLANT AREA

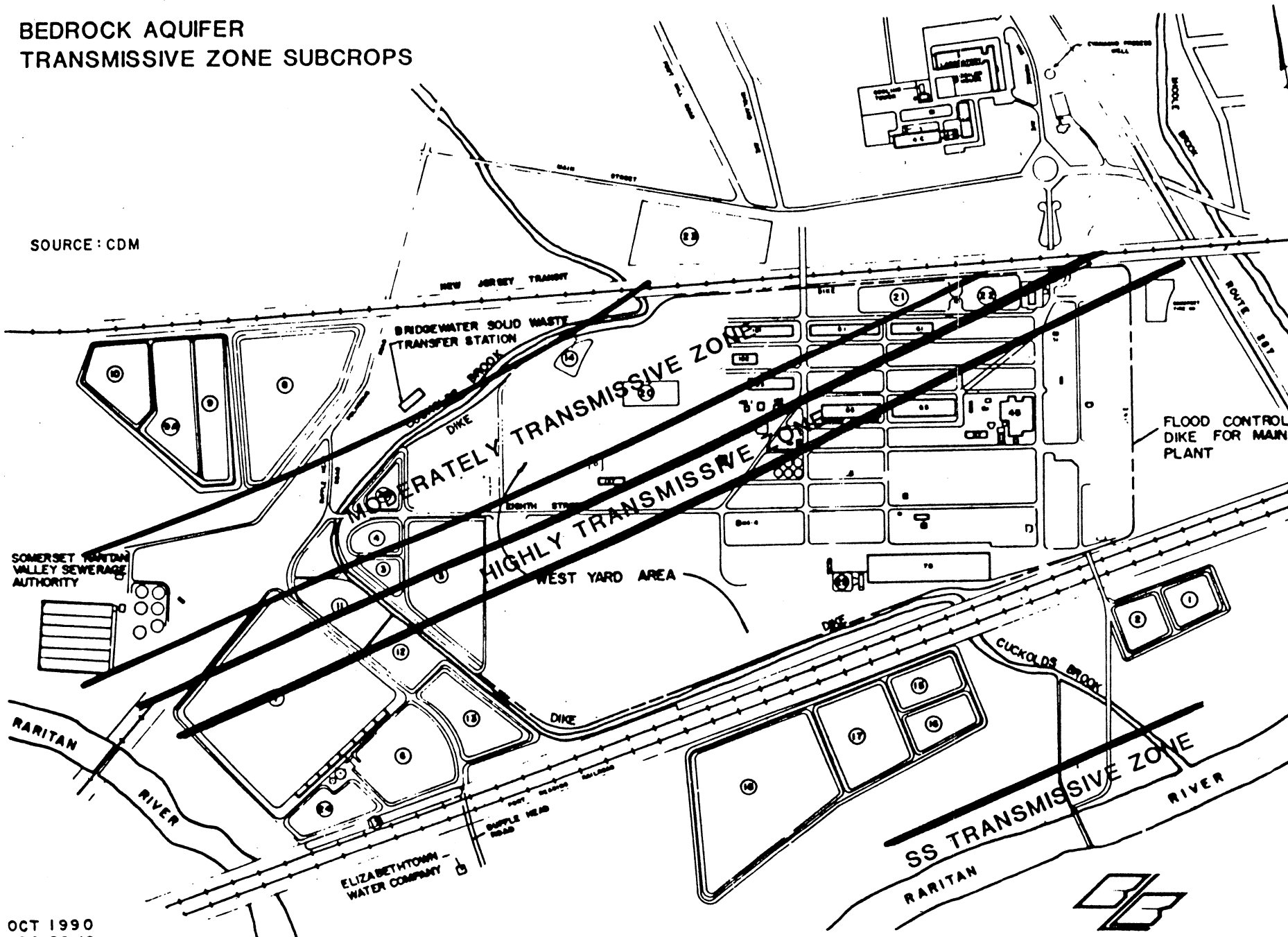
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FIGURE 26

BEDROCK AQUIFER TRANSMISSIVE ZONE SUBCROPS

SOURCE: CDM



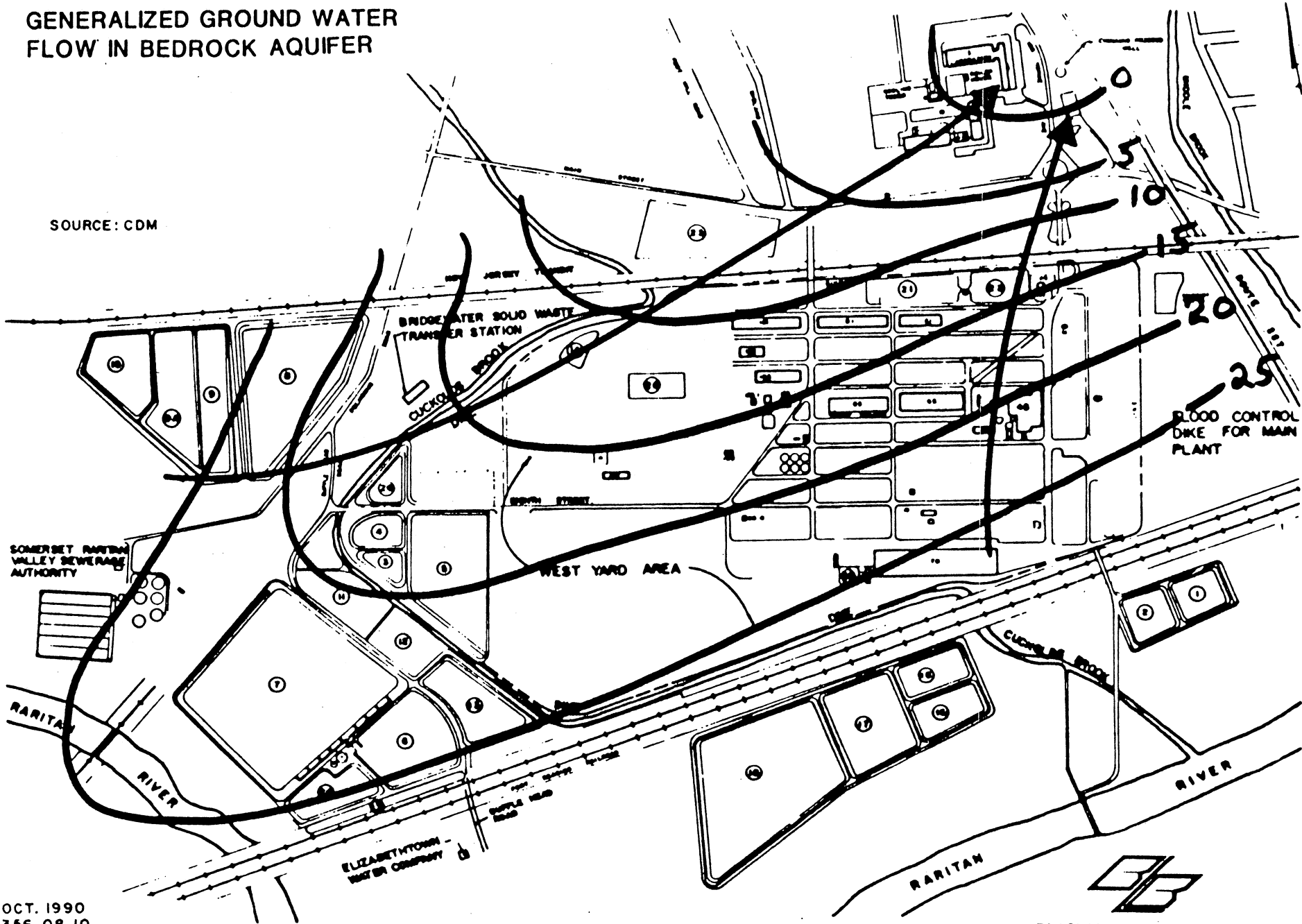
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FIGURE 27

GENERALIZED GROUND WATER FLOW IN BEDROCK AQUIFER

SOURCE: CDM



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FIGURE 28

TYPICAL SAND AND GRAVEL AQUIFER POTENTIOMETRIC SURFACE CONTOUR MAP

← DIRECTION OF
GROUNDWATER FLOW

ELEVATIONS REFER TO CYANAMID DATUM.
SUBTRACT 69.29 TO CONVERT TO U.S.G.S.

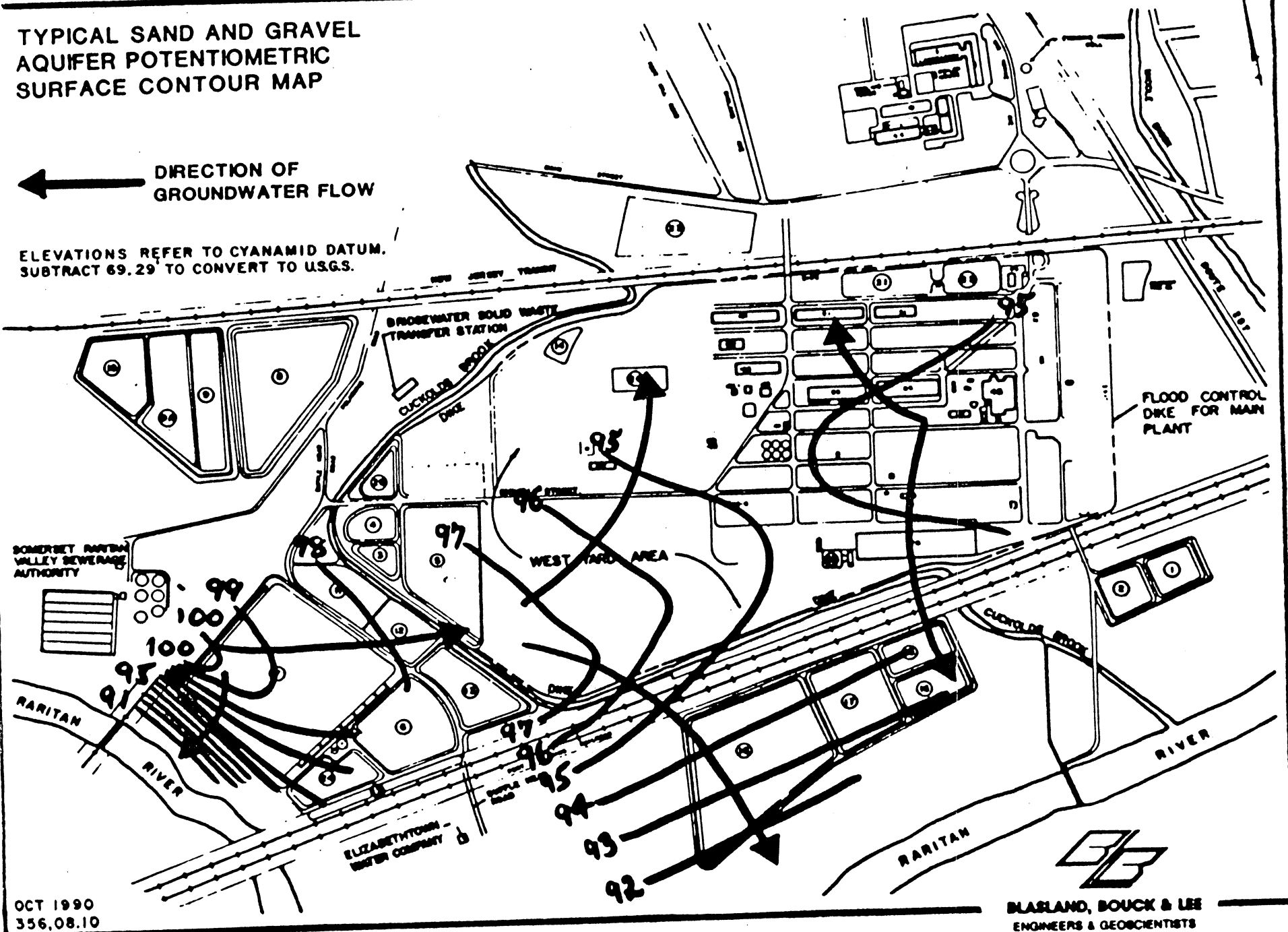
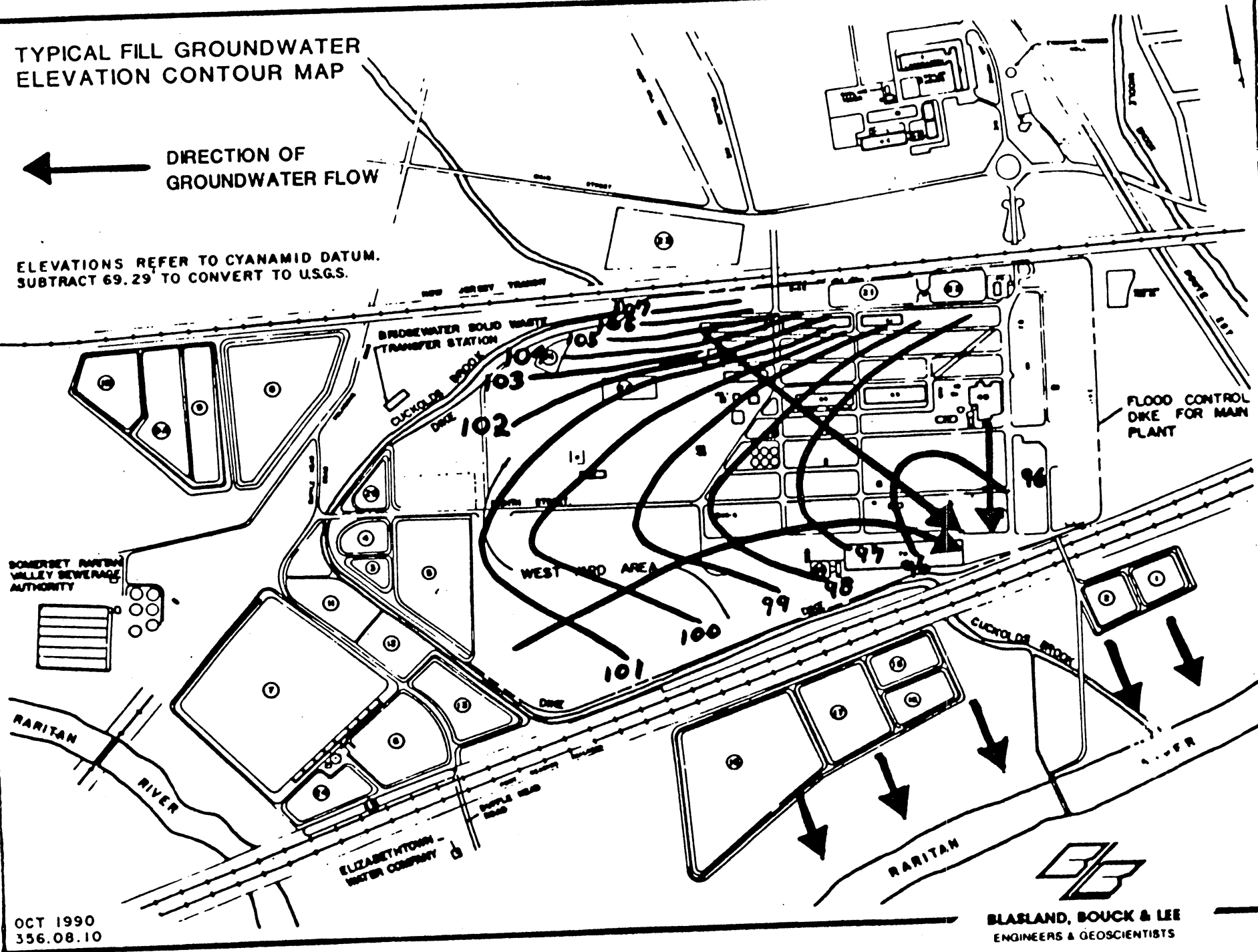


FIGURE 29

TYPICAL FILL GROUNDWATER ELEVATION CONTOUR MAP

← DIRECTION OF
GROUNDWATER FLOW

ELEVATIONS REFER TO CYANAMID DATUM.
SUBTRACT 69.29 TO CONVERT TO U.S.G.S.

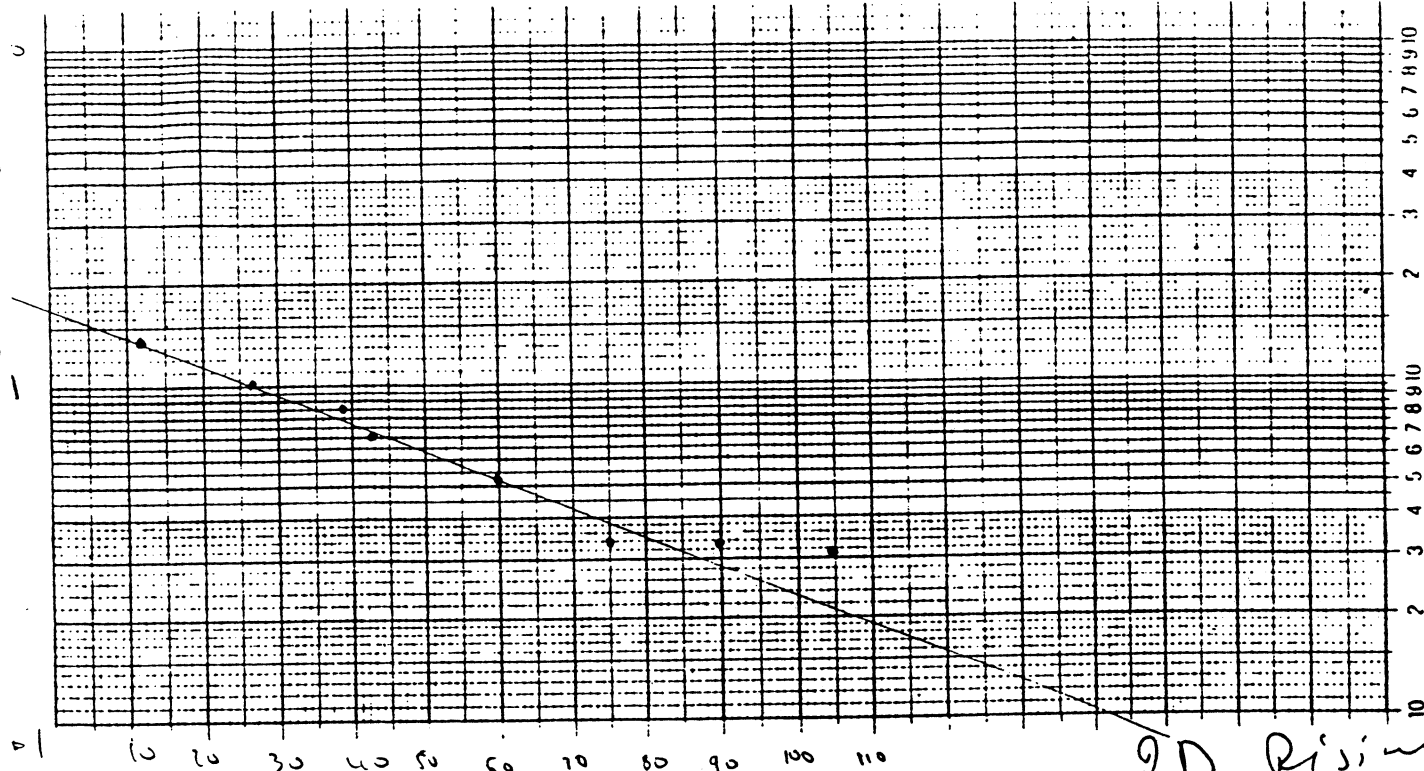


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FIGURE 30

APPENDIX I



2D Rissiny

$$t = 28 \quad y_t = 1 \quad \frac{1}{t} \ln \frac{y_0}{y_t} = \frac{1}{28} \ln \frac{2.25}{1} = 0.024 \text{ sec}^{-1}$$

$$\frac{L}{r_w} = 12 \quad A = 1.33 \quad B = 0.25 \quad C = 1.44$$

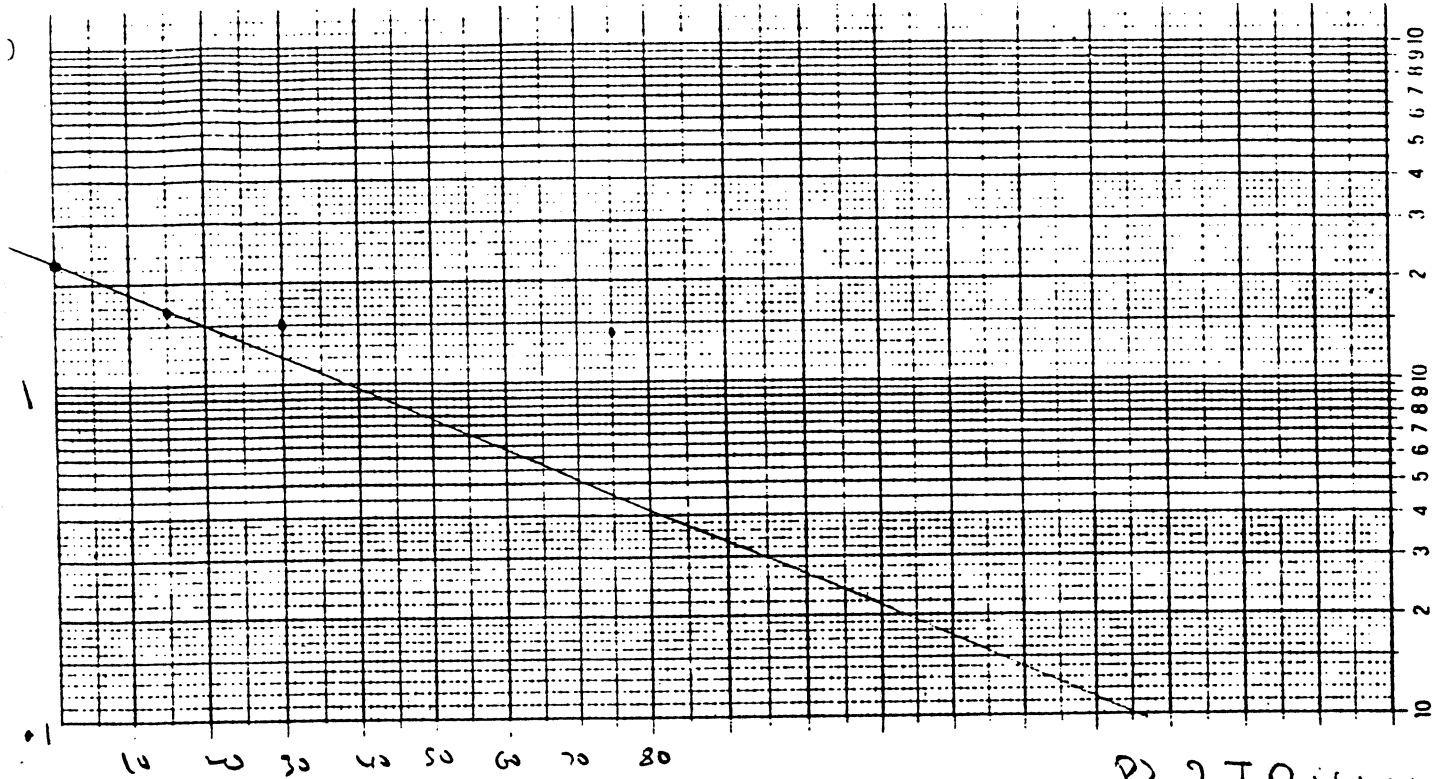
$$\ln \left(\frac{R_e}{r_w} \right) = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w} \right]^{-1} = \left[\frac{1.1}{\ln(15/0.25)} + \frac{1.44}{3/0.25} \right]^{-1} = [0.268 + 0.162]^{-1} =$$

$$[0.43]^{-1} = 2.326$$

$$K = \frac{(r_c^2) \ln(R_e/r_w)}{2h} \frac{1}{t} \ln \frac{y_0}{y_t} = \frac{(\frac{1}{12})^2 \cdot 2.326}{2.3} \cdot 0.024 = 0.000078 \text{ ft/sec}$$

$$= 7.81 \text{ E-5 ft/sec}$$

$$4.68 \text{ E-3 ft/min}$$



$$t = 3.8 \quad y_1 = 1 \quad \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{1}{3.8} \ln \frac{2.25}{1} = 0.0213$$

P22 IR 11-7

$$\frac{L}{r_w} = 12 \quad A = 1.39 \quad B = 0.25$$

$$\rho_w \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln[(O-H)/r_w]}{L/r_w} \right]^{-1}$$

$$= \left[\frac{1.1}{\ln(5.5/1.25)} + \frac{1.39 + 0.25 \ln[(16.75 - 5.5)/1.25]}{3/1.25} \right]^{-1}$$

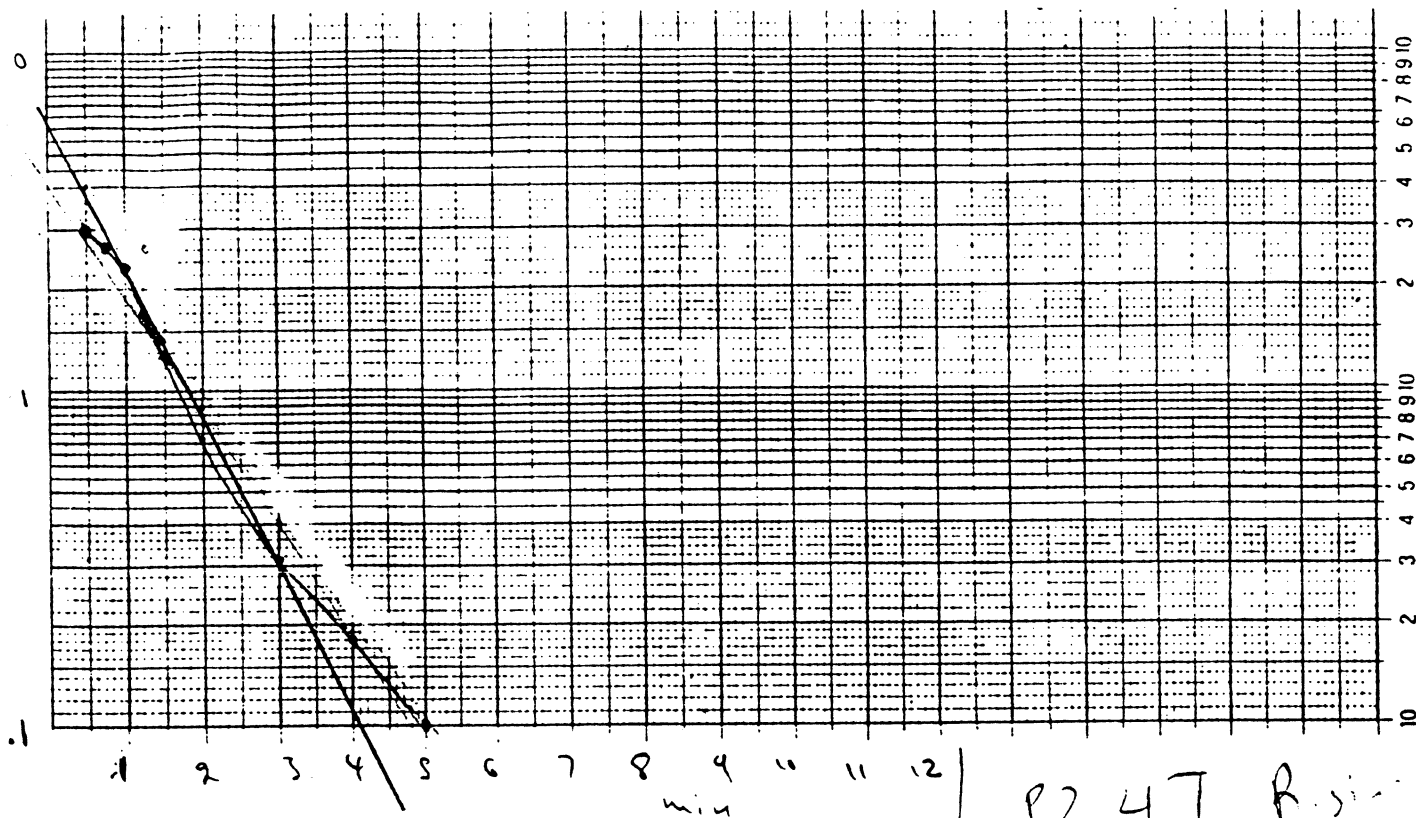
$$= (0.356 + 0.194)^{-1} = (0.55)^{-1} = 1.818$$

$$K = \frac{r_c^2 \ln \frac{R_e}{r_w}}{2L} \cdot \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{\left(\frac{1}{12}\right)^2 \cdot 1.818}{2.3} \cdot 0.0213 = 0.0000448 \text{ ft/sec}$$

$$4.48 \text{ E} - 5 \text{ ft/sec}$$

$$2.69 \text{ E} - 3 \text{ ft/min}$$

$$1.47 \text{ E} - 6 \text{ cm/sec}$$



P2 4 I R. S. i. n.

$$t = 3 \text{ min } y_t = .3 \text{ ft } \frac{1}{t} \ln \frac{y_0}{y_t} = \frac{1}{3} \ln \frac{0.25}{.3} = 1.012 \text{ min}^{-1}$$

$$\frac{L}{rw} = 12 \quad A = 1.38$$

$$B = 0.25$$

$$y \frac{R_0}{rw} = \left[\frac{1.1}{\ln(H/rw)} + \frac{A + B \ln[(D-H)/rw]}{L/rw} \right]^{-1}$$

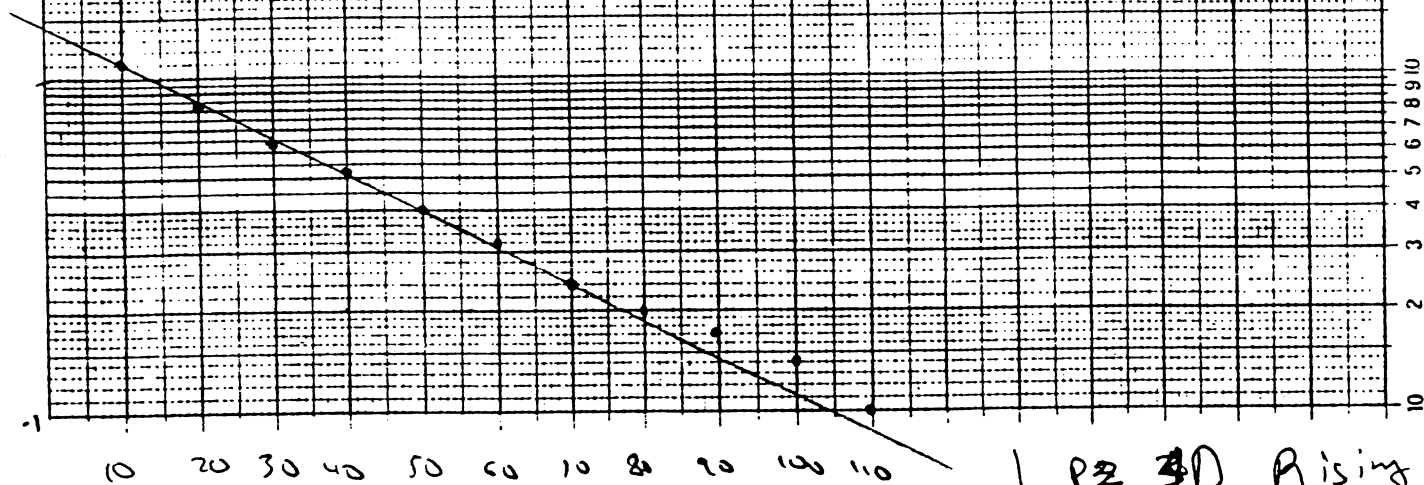
$$= \left[\frac{1.1}{\ln(5.5/.25)} + \frac{1.38 + 0.25 \ln[(14.5 - 5.5)/.25]}{3/.25} \right]^{-1}$$

$$= [0.356 + 0.190]^{-1} = (0.546)^{-1} = 1.832$$

$$K = \frac{r_c^2 \ln(R_c/rw)}{2L} \frac{1}{t} \ln \frac{y_0}{y_t} = \frac{\left(\frac{1}{12}\right)^2}{2 \cdot 3} 1.832 \cdot 1.012 = 0.00215 \text{ ft/min}$$

$$2.15 \text{ E-3 ft/min}$$

$$1.1 \text{ E-3 cm/sec}$$



$$t=50 \quad y_t = .4 \quad \frac{1}{t} \ln \frac{y_0}{y_t} = \frac{1}{50} \ln \frac{1.4}{.4} = 0.025 \text{ sec}^{-1}$$

$$\frac{L}{r_w} = 12 \quad A = 1.38$$

$$B = 0.25$$

$$C = 1.94$$

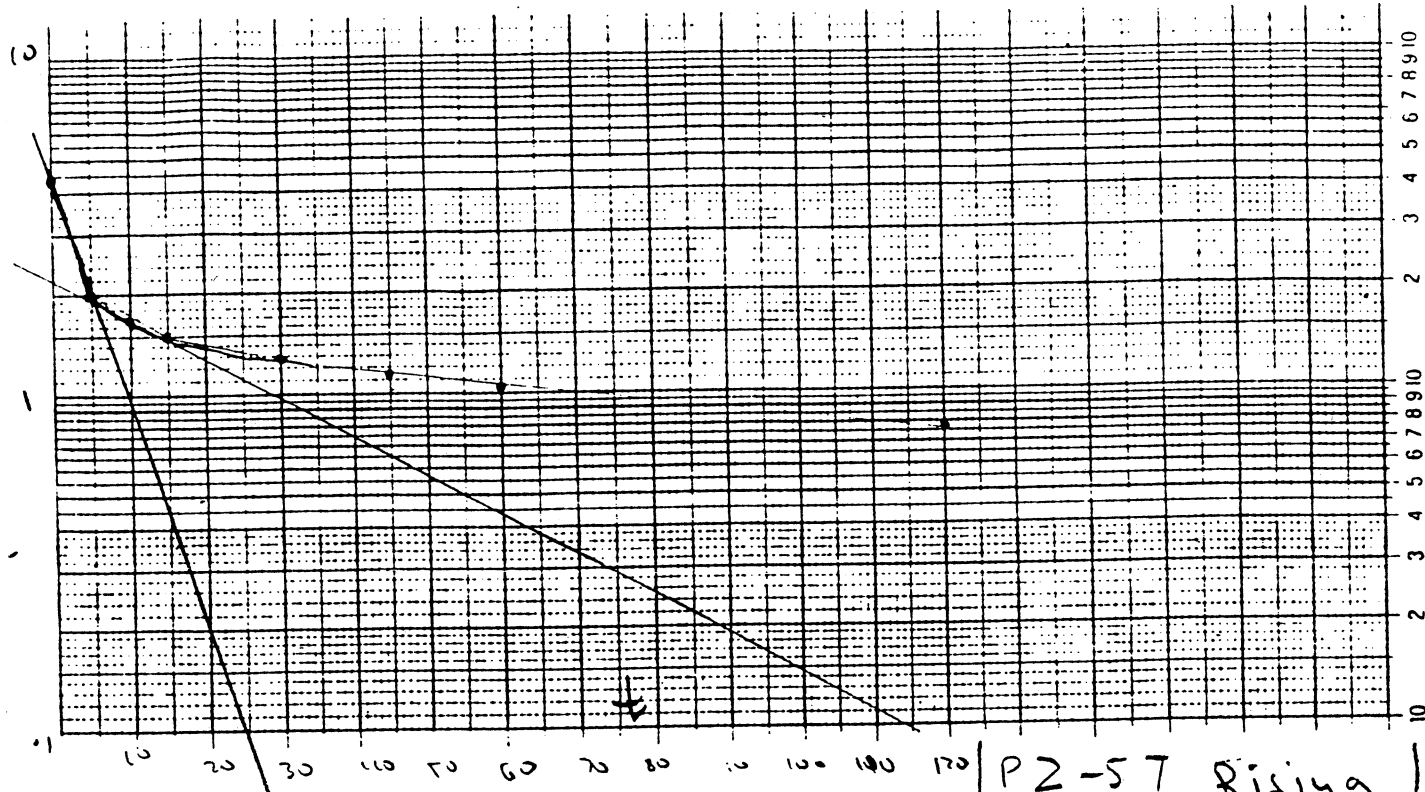
$$\ln \left(\frac{Re}{r_w} \right) = \left[\frac{1.1}{\rho u (H/r_w)} + \frac{C}{L/r_w} \right]^{-1} = \left[\frac{1.1}{\ln(14.5/1.25)} + \frac{1.94}{3/1.25} \right]^{-1}$$

$$= [0.271 + 0.162]^{-1} = [0.433]^{-1} = 2.309$$

$$k = \frac{(r_c)^2 \rho u (Re/r_w)}{2L} \frac{1}{t} \ln \left(\frac{y_0}{y_t} \right) = \frac{\left(\frac{1}{12} \right)^2 2.309}{2.3} 0.025 = 0.0000668$$

$$6.681 \text{ E-5 } \mu\text{t/sec}$$

$$4.009 \text{ E-3 } \mu\text{t/min}$$



Early $t=20$ $y_+ = 0.2$ $\frac{1}{20} \ln \frac{y_0}{y_+} = \frac{1}{20} \ln \frac{4.42}{0.2} = 0.155$

$\frac{r_e}{r_w} = 12$ $A = 1.37$
 $B = 0.25$

$$\frac{r_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln[(D-H)/r_w]}{L/r_w} \right]^{-1}$$

$$= \left[\frac{1.1}{\ln(7.5/0.25)} + \frac{1.37 + 0.25 \ln[(15.5 - 7.5)/0.25]}{3/0.25} \right]^{-1}$$

$$= [0.323 + 0.187]^{-1} = [0.51]^{-1} = 1.961$$

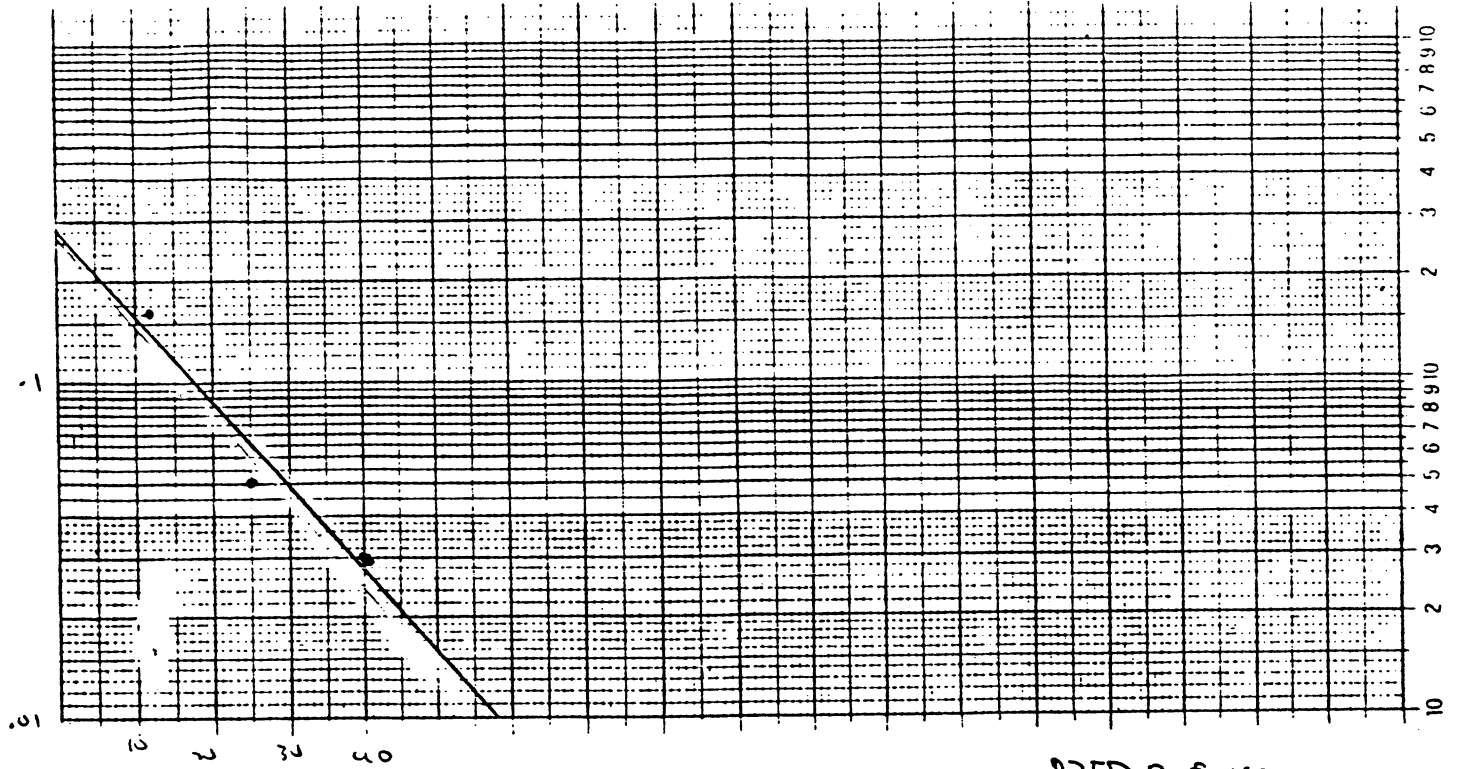
$$k = \frac{r_e^2 \ln\left(\frac{r_e}{r_w}\right)}{2h} \cdot \frac{1}{t} \ln \frac{y_0}{y_+} = \frac{\left(\frac{1}{12}\right)^2 \cdot 1.961}{2 \cdot 3} \cdot 0.155 = 0.00035 \text{ ft/sec}$$

1.2 $t=30$ $y_+ = 0.45$ $\frac{1}{30} \ln \frac{4.42}{0.45} = 0.051$

$$k = \frac{\left(\frac{1}{12}\right)^2 \cdot 1.961}{2 \cdot 3} \cdot 0.051 = 0.000116 \text{ ft/sec}$$

$= 1.16 \text{ ft/sec}$
 6.95 ft/min
 3.8 cm/sec

3.518 ft/sec
 2.11 ft/min
 1.15 cm/sec



P25D RISING

$$t = 30 \quad y_d = 0.05 \quad \frac{1}{t} \ln \frac{y_0}{y_d} = \frac{1}{30} \ln \frac{0.28}{0.05} = 0.057$$

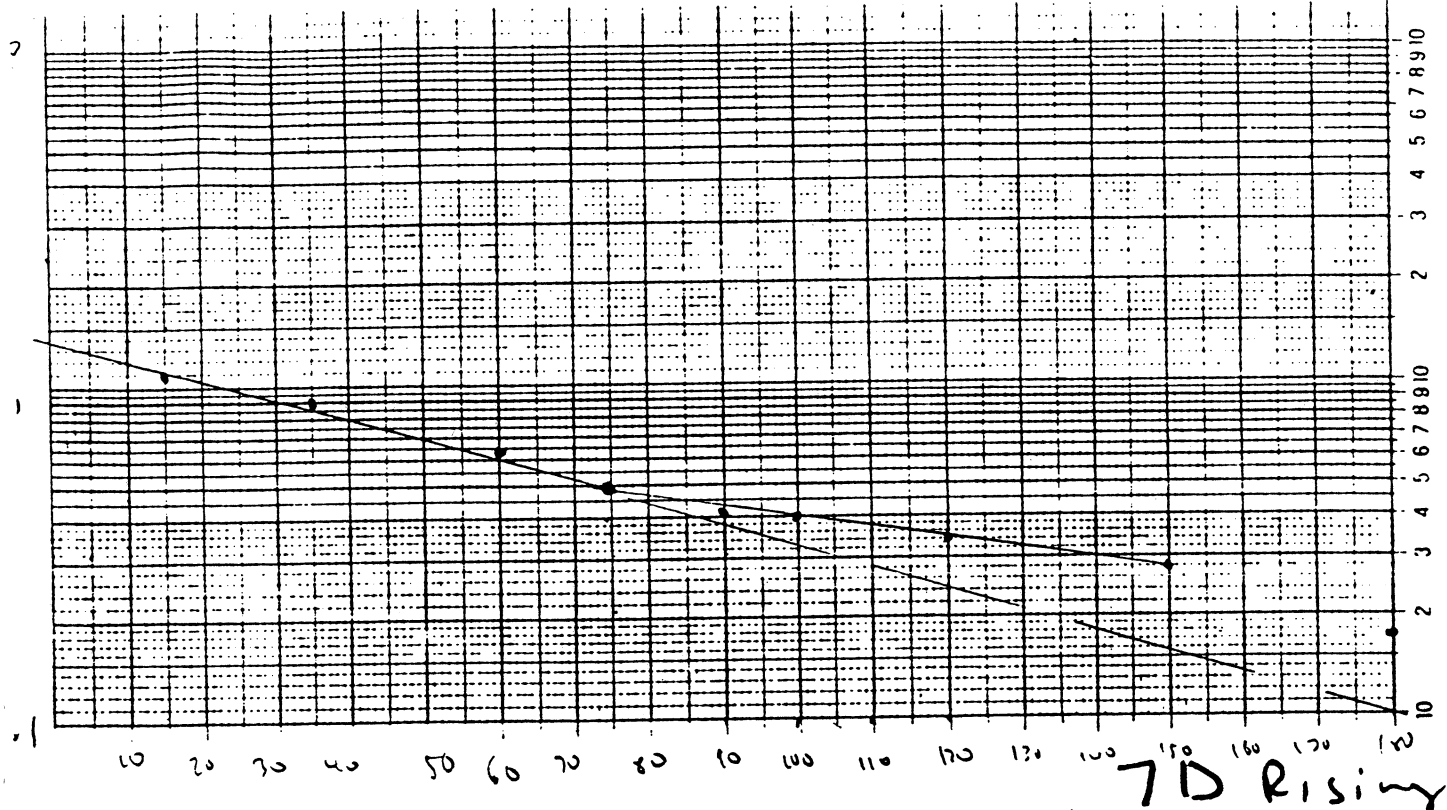
$$\frac{L}{r_w} = 12 \quad \begin{aligned} A &= 1.38 \\ B &= 0.25 \\ C &= 1.94 \end{aligned}$$

$$\begin{aligned} u\left(\frac{Re}{r_w}\right) &= \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{H/r_w} \right]^{-1} = \left[\frac{1.1}{\ln(15.5/0.25)} + \frac{1.94}{3/0.25} \right]^{-1} \\ &= [0.266 + 0.162] = (0.428)^{-1} = 2.336 \end{aligned}$$

$$k = \frac{r_c^2 P_u(Re/r_w)}{2h} \frac{1}{t} \ln \frac{y_0}{y_d} = \frac{\left(\frac{1}{12}\right)^2 2.336}{2.3} 0.057 = 0.000154$$

$$1.54 \text{ E-4 ft/sec}$$

$$9.25 \text{ E-3 ft/min}$$



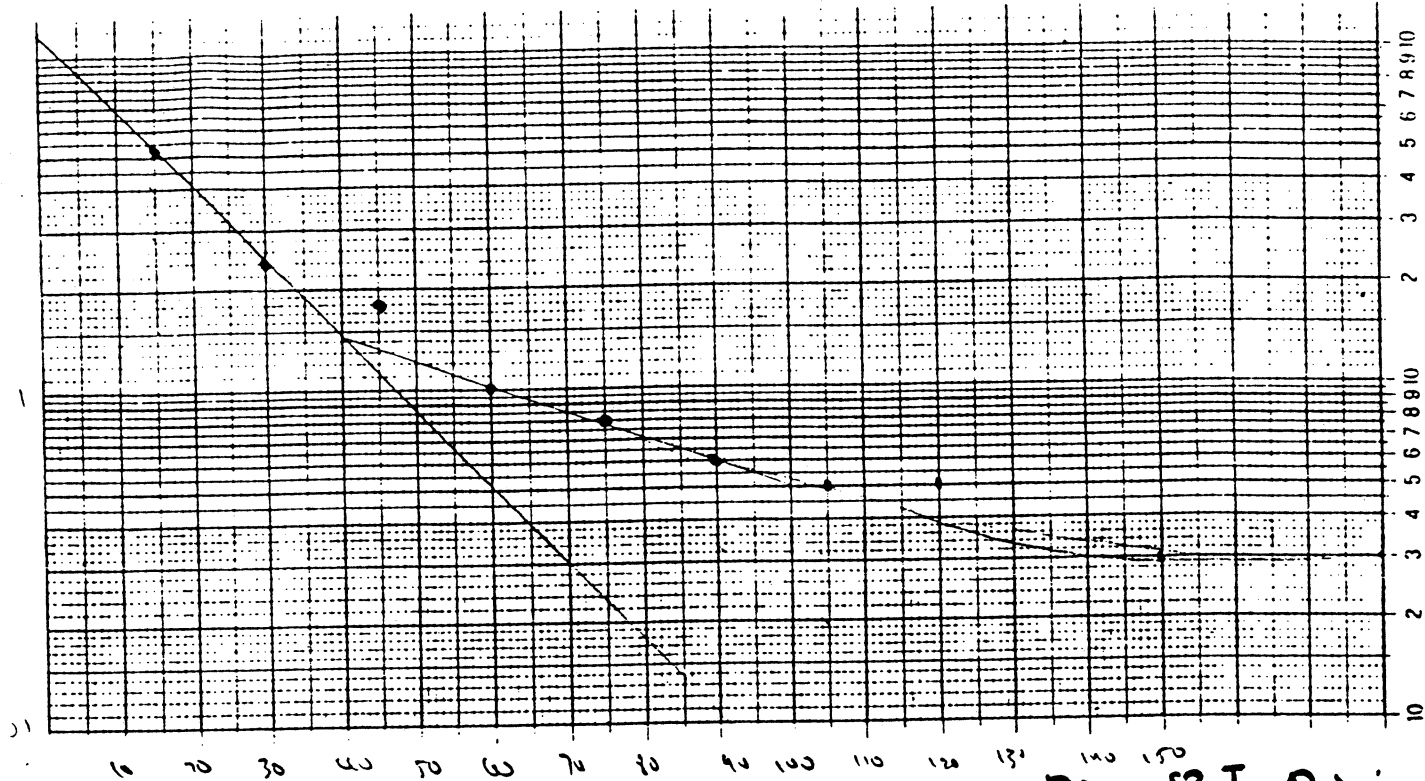
$$=10 \quad y_4 = 1.2 \quad \frac{1}{t} \ln \frac{y_0}{y_4} = \frac{1}{10} \ln \frac{1.4}{1.2} = 0.0154$$

$$-l/r_w = 12 \quad A = 1.33 \quad B = 0.25 \quad C = 1.94$$

$$u(R_e/r_w) = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{l/r_w} \right]^{-1} = \left[\frac{1.1}{\ln(9.7/.25)} + \frac{1.94}{3/.25} \right]^{-1} = [0.301 + 0.162]^{-1} = [0.463]^{-1} = 2.1598$$

$$k = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{(\frac{1}{12})^2 2.1598}{2.3} 0.0154 = 3.85 \times 10^{-5} \text{ ft/sec} = 2.31 \times 10^{-3} \text{ g/min}$$

$$y_0 = 2.25 \quad k \approx 9 \times 10^{-3} \text{ g/min}$$



p2 8 I Rising

$$= 20 \quad y_2 = 0.4 \quad y_2 = 1.2 \quad \frac{1}{t} \ln \frac{y_0}{y_2} = \frac{1}{20} \ln \frac{1.2}{0.4} = 0.0549$$

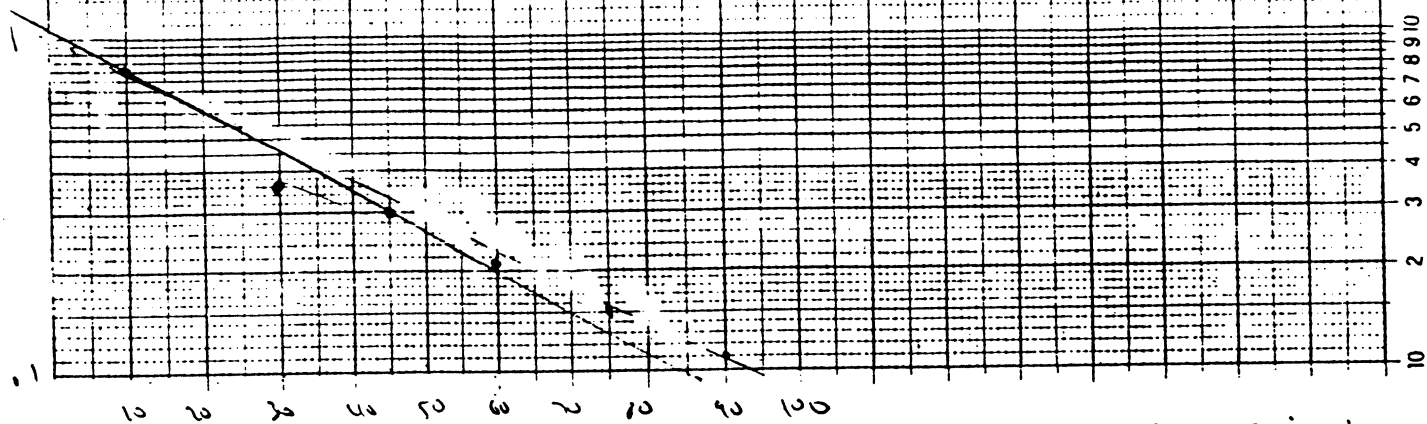
$$r_w = 12 \quad A = 1.38, B = 0.25, C = 1.44$$

$$\left(\frac{R_e}{r_w} \right) = \left[\frac{1.1}{\ln(h/r_w)} + \frac{A + B \left[(D-h)/r_w \right]}{L/r_w} \right]^{-1} = \left[\frac{1.1}{\ln(6.32/.25)} + \frac{1.38 + 0.25 \left[\frac{15.32 - 6.32}{.2} \right]}{3/.25} \right]^{-1}$$

$$= \left[0.300 + 0.190 \right]^{-1} = (0.5)^{-1} = 2.0$$

$$K = \frac{r_w^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln \frac{y_0}{y_2} = \frac{\left(\frac{1}{12} \right)^2 2.0}{2.3} 0.0549 = 1.27 \text{ E-4 ft/sec}$$

$$7.63 \text{ E-3 ft/sec}$$



$$= 45 g_x = 0.3 \quad y_0 = 1.1 \quad \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{1}{45} \ln \frac{1.1}{0.3} = 0.0289$$

8D rising

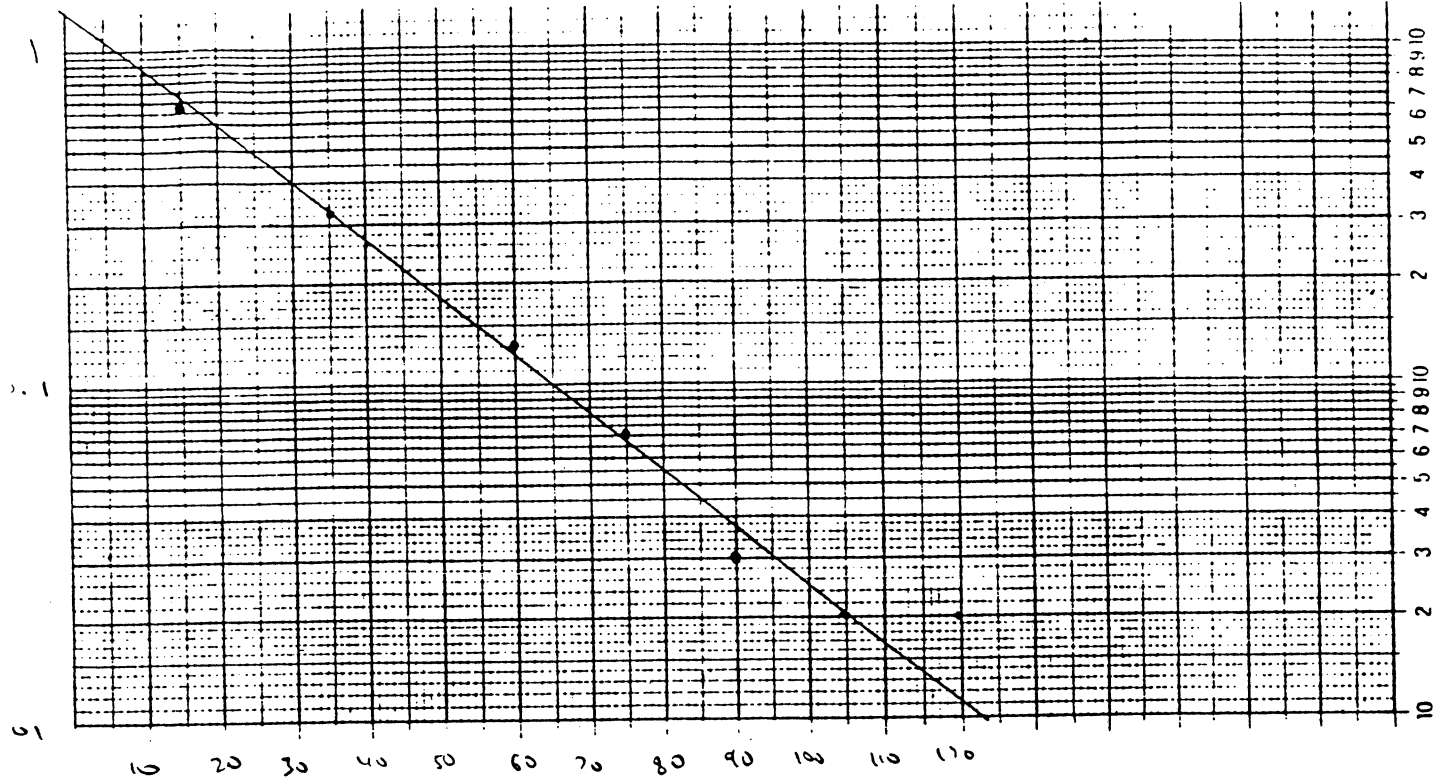
$$L/r_w = 12 \quad A = 1.38 \quad B = 0.25 \quad C = 1.94$$

$$h(R_e/r_w) = \left[\frac{1.1}{\ln(4/r_w)} + \frac{C}{L/r_w} \right]^{-1} = \left[\frac{1.1}{\ln(16.3/0.25)} + \frac{1.94}{12/0.25} \right]^{-1} =$$

$$= [0.263 + 0.162]^{-1} = [0.425]^{-1} = 2.353$$

$$k = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{\left(\frac{1}{12}\right)^2 2.353}{2.3} \quad 0.0289 = 7.87 \times 10^{-5} \text{ ft/sec}$$

$$4.7 \times 10^{-3} \text{ ft/min}$$



$$= 65 \quad y_6 = 0.1 y_0 = 1.3 \quad \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{1}{65} \ln \frac{1.3}{0.1} = 0.0395$$

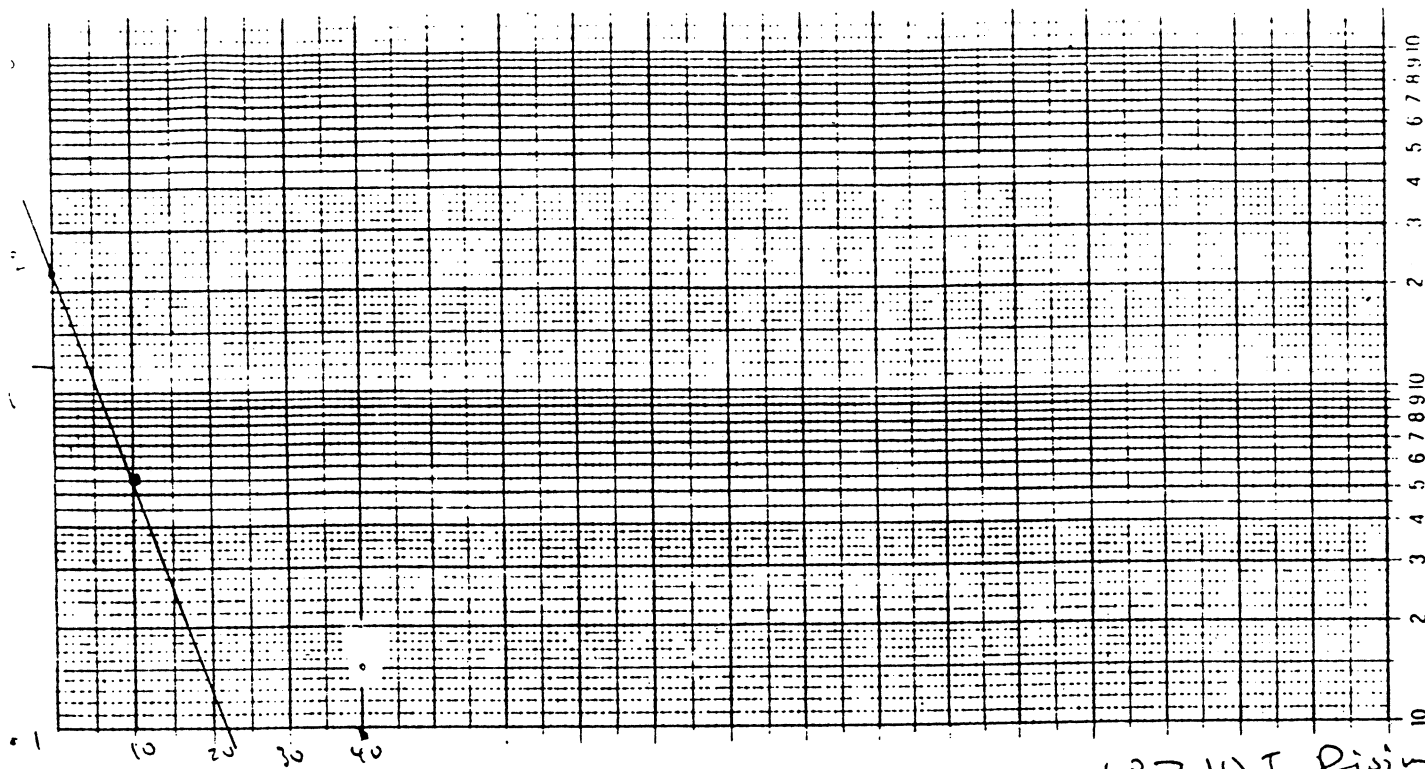
$$r_w = 12 \quad A = 1.38, B = 0.25, C = 1.94$$

$$Re/r_w = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{4r_w} \right]^{-1} = \left[\frac{1.1}{\ln(14.95/12)} + \frac{1.94}{3/0.25} \right]^{-1} = [0.269 + 0.162]^{-1} = [0.431]^{-1} = 2.320$$

$$K = \frac{r_c^2 \ln(Re/r_w)}{2L} \cdot \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{(\frac{1}{12})^2 \cdot 2.320}{2 \cdot 3} \cdot 0.0395 = 1.06 \cdot 10^{-4} \text{ ft/sec}$$

$$6.36 \cdot 10^{-3} \text{ m/min}$$

9D R...



(PZ) I Rising

$$t=10 \quad y_0=0.55 \quad \cdot \quad \frac{1}{t_0} \ln \frac{2.25}{.55} = 0.141 \text{ sec}^{-1}$$

$$\frac{h}{r_w} = 12 \quad A = 1.38$$

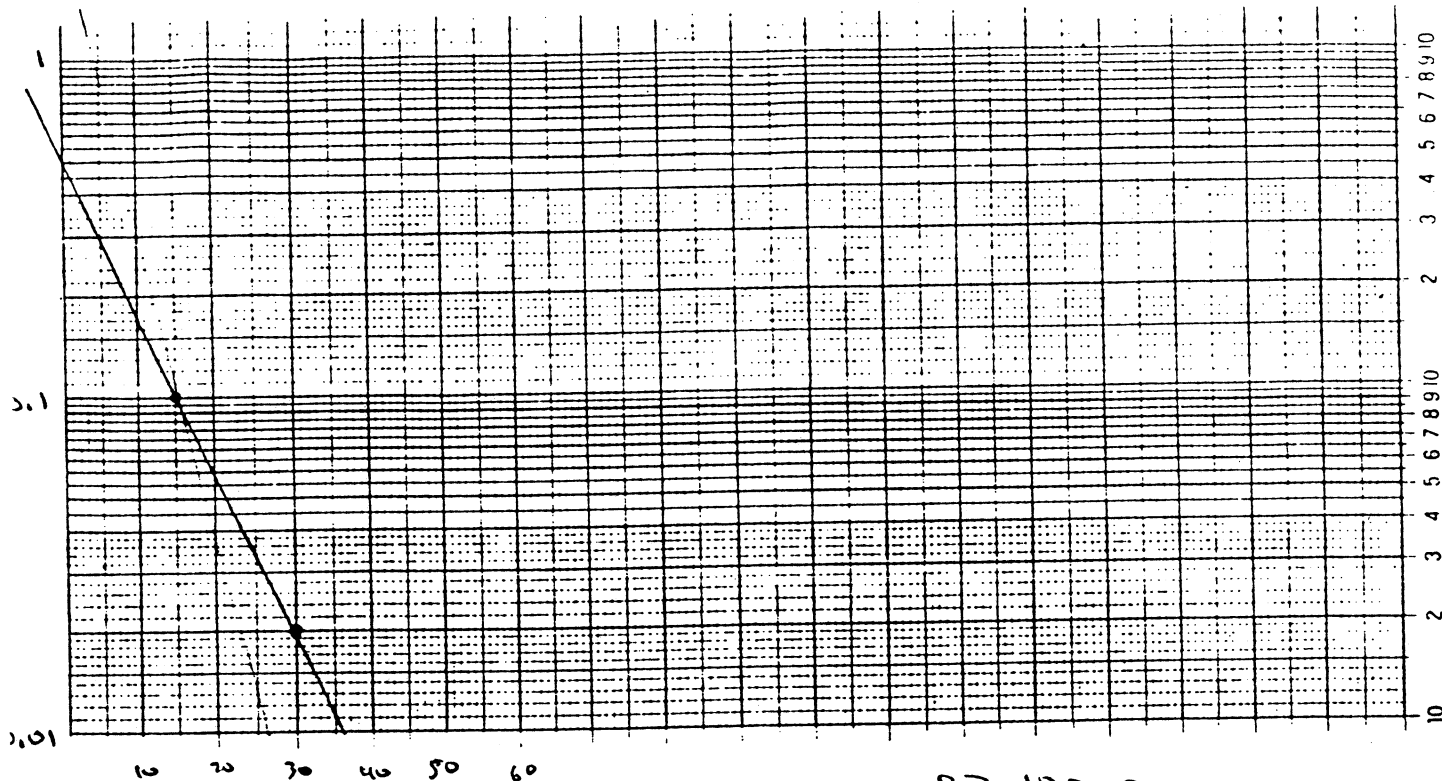
$$B = 0.25$$

$$\left(\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + 10 \ln[(Q-H)/r_w]}{L/r_w} \right]^{-1} = 1.832 \right.$$

$$K = \frac{(\frac{1}{12})^2 \cdot 1.832}{2.3} \cdot 0.141 = 0.00212037 = 2.91E-4 \text{ ft/sec}$$

$$1.79E-2 \text{ ft/min}$$

✓ Power line $K = 8.97E-3 \text{ ft/min.}$



$$= 20 \quad y_1 = 0.1 \quad y_0 = 0.5 \quad \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{1}{20} \ln \frac{0.5}{0.1} = 0.08$$

$$r_w = 12 \quad A = 1.38, \quad B = 0.25, \quad C = 1.94$$

$$\gamma(R_e/r_w) = \left[\frac{1.01}{\ln(4/r_w)} + \frac{C}{4r_w} \right]^{-1} = \left[\frac{1.01}{\ln(15.2/1.25)} + \frac{1.94}{3/1.25} \right]^{-1} = [0.268 + 0.162]^{-1} = [0.43]^{-1} = 2.326$$

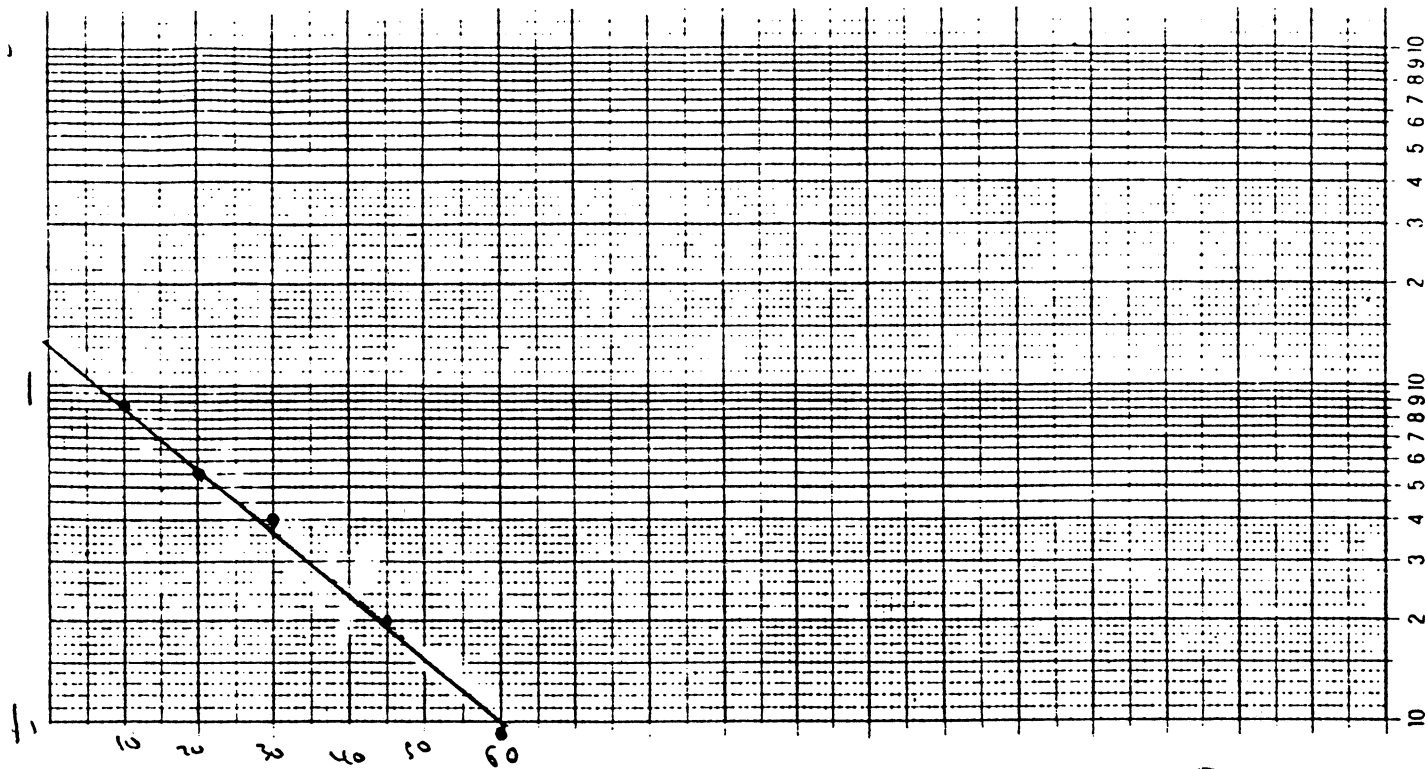
$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t} \ln \left(\frac{y_0}{y_1} \right) = \frac{\left(\frac{1}{12} \right)^2 \cdot 2.326}{2 \cdot 3} \cdot 0.08 = 2.154 E-4 \text{ g/g/sec}$$

1.29 E-2 g/min

$$\text{Early } \frac{1}{20} \ln \frac{2.25}{0.1} = 0.156$$

$$K = 4.9 E-4 \text{ g/g/sec}$$

2.5 E-2 g/min



$$= 15 \quad y_1 = 0.7 \quad y_0 = 1.3 \quad \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{1}{15} \ln \frac{1.3}{0.7} = 0.041 \quad \underline{PZ-11D R}$$

$$r_w = 12 \quad C = 1.94$$

$$\frac{1}{R_e(r_w)} = \left[\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w} \right]^{-1} = \left[\frac{1.1}{\ln(46.4/r_w)} + \frac{1.94}{3/0.25} \right]^{-1} = [0.263 + 0.152]^{-1} \\ = [0.425]^{-1} = 2.353$$

$$k = \frac{r_c^2 \ln(R_e(r_w))}{2.4} \cdot \frac{1}{t} \ln \frac{y_0}{y_1} = \frac{\left(\frac{1}{12}\right)^2 2.353}{2.3} \cdot 0.041 = 1.12 \text{E-4} \text{ 1/s} \\ 6.7 \text{E-3 g/m}^2$$



Attachment 4

ATTACHMENT 4

ANALYSIS OF TENTATIVELY IDENTIFIED COMPOUNDS

ANALYSIS OF TENTATIVELY IDENTIFIED COMPOUNDS

The presence of Tentative Identified Compounds (TICs)¹ in certain RI samples was identified by the NJDEPE as a concern in a July 19, 1991 comment letter from the NJDEPE to Cyanamid. In response, Cyanamid initiated an in-depth TIC evaluation including a statistical and toxicological assessment of specific TICs. Cyanamid's investigative efforts are summarized in its August 22, 1991 and October 31, 1991 letters to NJDEPE. The conclusions of the TIC investigation, as approved by the NJDEPE (December 3, 1991 letter), are that TICs do not warrant further consideration as a factor in determining remedial objectives and the standard Target Compound List (TCL) of analytes should continue to be used to define remediation goals.

In order to clearly present the relevant details of the TIC investigation, excerpts from the July 19, 1991 and August 22, 1991 letters have been included in the following section and the remaining three letters, which focus exclusively on TICs, are presented in their entirety.

1.1 TICs Investigation

As indicated above, a series of correspondence between NJDEPE and American Cyanamid from July through December 1991 was used to resolve the NJDEPE's requested clarification on TICs. The five letters included:

Footnote:

¹TICS - Tentatively Identified Compounds (TICs) are compounds whose presence in a sample is indicated by a GC/MS computer library search but whose identity is not confirmed with a chromatogram generated from an authentic standard for the specific compound of interest. Therefore, the identification of these compounds can only be considered tentative.

1. July 19, 1991 letter from NJDEPE to Cyanamid (comments on Soils RI Report/FS Work Plan);
2. August 22, 1991 letter from Cyanamid to NJDEPE (response to NJDEPE comments on Soils RI Report/FS Work Plan);
3. September 30, 1991 letter from NJDEPE to Cyanamid (NJDEPE's contingent approval of Cyanamid's response to NJDEPE's comments) (letter attached);
4. October 31, 1991 letter and attachment from Cyanamid to NJDEPE (Supplemental TIC Evaluation) (letter attached); and
5. December 3, 1991 letter from NJDEPE to Cyanamid (final approval of the TIC evaluation) (letter attached).

1. July 19, 1991 Letter

The July 19, 1991 letter from NJDEPE to Cyanamid comprises NJDEPE's comments on the 1990 Soils RI Report/FS Work Plan. One of these comments, Comment No. 5, concerns the issue of TICs:

"A cursory review of the results shows that very few Target Compound List (TCL) compounds are found in the surface soils. The majority of organic compounds is found in the Tentatively Identified Compound fraction (TIC). TICs are 50 to 75% of the total detected organic fraction. Based on identifiable compounds, some areas of the site may appear to pose no threat to human health; however, considering the past activities of the site, visual observations by NJDEP representatives during site visits and test pit sampling, and the magnitude of TICs at the site, further investigation of these TICs is warranted.

As a first step in evaluating the TICs, Cyanamid needs to prepare a detailed summary list of the predominant (concentration and frequency) TICs as well as statistics which show the ratio of the concentration of TICs to the concentration of identified compounds in each sample and investigative area. Cyanamid then must compare the predominant TICs to products and raw materials used at the site, and review the literature for toxicity, physical characteristics, and degradability data for these TICs or their suspected source compound (raw material or product). If large quantities of TICs are still unaccounted for in areas containing few TCL compounds, then some non-specific toxicity and carcinogenicity testing is warranted (i.e. Microtox, Ames, animal testing). Such tests could not generate an absolute value but will be compared to control results from natural background soils found in uncontaminated and non-industrial areas of the site (i.e. Hill Property and/or North of the Central Railroad of New Jersey tracks). Enclosed is the 1989 guidance chart (Enclosure-1) that is used in the ECRA program to evaluate TICs found on site. Currently this strategy is being implemented at Southland Chemical, a dye manufacturer."

2. August 22, 1991 Letter

In the August 22, 1991 letter to NJDEPE, Cyanamid responded to NJDEPE's July 19, 1991 comments on the Soils RI Report/FS Work Plan. (Minor revisions to this letter were subsequently submitted on August 27, 1991). In summary, Cyanamid's response to NJDEPE Comment No. 5 focused on the following areas:

- a. Categorization of the TIC data into "known", "known group" and "unknown" TIC analytical results;
- b. Compilation of TIC summary tables showing the frequency of TIC identification in surface and subsurface samples and the TIC concentration ranges;
- c. Analysis of the TIC data;
- d. Screening of 28 TICs that were most frequently found or that were presented in the highest concentrations. These TICs were identified to undergo a subsequent literature and data base search for relevant toxicological information; and
- e. The conclusion that further evaluation of "unknown" TICs is unwarranted.

The complete text of Cyanamid's response to Comment No. 5 is as follows:

A major effort has been completed to identify, summarize, and evaluate TICs identified in the "+ 30 peaks" Target Compound List (TCL) scan for soils. A summary of the findings is presented below.

1. Data Summary

- a. *The initial evaluation step included the compilation of all the relevant Main Plant surface soil TIC data. This information was then summarized and presented (Attachment 4 - Tables - "Main Plant Soils - Detailed TIC data") according to the following criteria:*

- i. *The TIC data from the 131 surface soil samples were divided into three categories; "known", "known group", or "unknown" TICs. This process was carried out for volatile organic compounds and semivolatiles;*
 - ii. *For the "known" or "known group" category the individual contaminants or contaminant groups and their respective concentrations were listed (For "unknowns" only the total "unknown" concentration was provided); and*
 - iii. *The three categories of TICs were then compared to the total volatile or semivolatile concentrations (TCL and TICs) and the percentage of this total which each TIC category comprises was computed for each sample.*
- b. *In the second step of the TIC analysis, a table was compiled (Attachment 5A, Tables- "Known TIC Summary - Volatile Organics, Surface Soils - Main Plant Area" and "Known TIC Summary - Semivolatiles, Surface Soils - Main Plant Area") that lists all the "known" and "known group" surface soil TICs. CAS numbers (when available) are included, as well as the number of detections of the TIC compound, the frequency of detection (as a percentage), and the high and low concentrations.*
- c. *In the final step of the TIC analysis, a comprehensive surface and subsurface analysis of the TIC data was compiled for volatiles and semivolatiles. A total of 131 surface samples and 243 subsurface*

samples were incorporated into this analysis of Main Plant TICs. These tables (Attachment 5B - Table - "Surface Soils - Main Plant Area, TIC Summary and Statistical Evaluation") include summaries of the following volatile and semivolatile information:

- i. Area (e.g., W-3, P-6, etc.) in which the sample was collected;*
- ii. Sample number (e.g., WS-85, PS-139);*
- iii. TCL concentration in ppm;*
- iv. TIC concentration in ppm;*
- v. The percentage of total volatiles/semivolatiles represented by total TICs;*
- vi. The percentage of total volatiles/semivolatiles represented by "known" TICs;*
- vii. The percentage of total volatiles/semivolatiles represented by "known groups" TICs; and*
- viii. The percentage of total volatiles/semivolatiles represented by "unknown" TICs.*

In addition to the Data Summary information described above (as presented in the tables), two additional approaches are being used to evaluate "known" or "known group" TIC data and "unknown" TIC data.

- 2. Supplementary "Known" and "Known Group" TIC Evaluation - A literature/database search will be used to attempt to identify toxicity/carcinogenicity of a select group of surface soil "known" and "known groups" of compounds. In order to select those compounds that will undergo a toxicity analysis, the list of 160 "known" and "known group" TICs will be screened to a practicable number of TICs which are*

representative of the site. The screening will be based on those TICs detected at a frequency of 5 percent or greater or those TICs which had concentrations greater than 10 ppm for volatiles or 100 ppm for base neutrals (10 times the NJDEP soil action levels). A total of 28 TICs will be evaluated for toxicity based on a literature review. These 28 TICs are highlighted with an "*" on Attachments 5A and 5B.

A summary of the literature search TIC evaluation will be presented to the NJDEP along with any recommendations for future work if deemed appropriate.

3. "Unknown" TIC Evaluation - A sample location map of the Main Plant was used to plot areas where "unknown" TICs in the surface soils would elevate a TCL concentration above the 1 ppm volatile and 10 ppm base neutral NJDEP soil action levels. This evaluation has been completed and the conclusions are summarized below. In this assessment, the surface soil samples have been the primary focus for the following reason: TICs in surface soils represent a more direct route of exposure for on-site workers than do those in subsurface soils. The RI/FS Work Plan specifically targeted areas that could potentially be subject to short-term action due to risks to worker health and safety. This rationale was first developed in the Endangerment Assessment.

Conclusions

Cyanamid has completed a comprehensive evaluation of the surface distribution of TICs in the Main Plant area. The following information was plotted:

1. Sample locations where TCL concentrations exceeded the 1 ppm volatile and 10 ppm base neutral (semivolatile) NJDEP action levels.
2. Sample locations where total TICs pushed the total concentration over the 1 or 10 ppm action level.

The results indicated that only three volatile surface samples from a total of 131 were elevated above the 1 ppm action level due to the presence of TICs. The highest concentration of TICs in any one of these samples was below 20 ppm. The review of semivolatiles demonstrated that a total of 53 samples were below the NJDEP base neutral action level of 10 ppm for TCL compounds only. Of these, 42 samples were driven over the 10 ppm base neutral (semivolatile) action level by TICs. Of these 42, only three exhibited total TICs greater than 500 ppm. (WS-40, WS-97, PS-58). In two of these samples (WS-40, PS-58) over 90 percent of the TICs were comprised of "unknown" TICs.

Based on these findings the following conclusions can be made:

1. The two semivolatile TIC "hot spots" (areas with TICs greater than 500 ppm and comprised of 90 percent or greater unknown TICs) are discrete locations and do not represent an area-wide "unknown" TIC concern. The elevated semivolatile "hot spots" represent only 2 of 42 surface sampling points that were evaluated based on TICs elevating TCL concentrations above NJDEP action levels; and
2. In general, the low concentrations and prevalence of "unknown" volatile and semivolatile TICs in the surface soils, when compared to the

significant TCL compound distribution throughout the Main Plant area, demonstrates that "unknown" TICs should be deleted from further consideration.

In conclusion, "unknown" TICs will not be further evaluated in responses to comments on the RI report. However, an additional assessment of "known" and "known groups" of TICs will be completed as discussed in comment 2 above. Cyanamid anticipates that the results of the literature/database search will support the position that TICs will not impact the remedial approach for this area of the site.

3. September 30, 1991 Letter

The September 30, 1991 letter from NJDEPE to Cyanamid states that Cyanamid's August 22, 1991 response to NJDEPE/USEPA comments is acceptable, provided that a literature search for the 28 "known" and "known group" TICs is submitted. (See attached letter).

4. October 31, 1991 Letter

The October 31, 1991 letter from Cyanamid to NJDEPE includes the results of the literature search for "known" and "known group" TICs and presents Cyanamid's conclusion that future work efforts regarding TICs are unwarranted. (See attached letter)

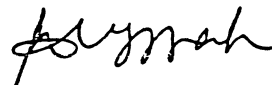
5. December 3, 1991 Letter

3. Please add a third column in the Table of Attachment 6, tabulating the approximate average concentration of the total contaminants in each area division.

Please submit the literature search for the "Known" and "Known Group" TICs evaluation along with any recommendations for future work if deemed appropriate, within thirty (30) calendar days after receipt of this letter.

If you have any questions, please contact me at (609)633-1455.

Sincerely,



Haiyesh Shah, Case Manager
Bureau of Federal Case Management

cm

c: Joyce Harney, USEPA
Mike Infurna, USEPA
Marc Romanell, DPFSR/BGWPA
Andrew Marinucci, DPFSR/BEERA



American Cyanamid Company
Bound Brook, NJ 08805
(201) 560-2000

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

October 31, 1991

Mr. Haiyesh Shah
NJ Department of Environmental Protection & Energy
Bureau of Federal Case Management
Division of Responsible Party Site Remediation
401 East State Street, 5th Floor
CN 028
Trenton, NJ 08625-0028

RE: Soils RI/FS Work Plan - Supplemental TIC Evaluation

Dear Mr. Shah:

Blasland, Bouck & Lee has prepared on behalf of American Cyanamid Company (Cyanamid) an analysis and literature search for 28 "known" and "known group" TICs (Tentatively Identified Compounds) referenced in the September 30, 1991 letter from the New Jersey Department of Environmental Protection and Energy (NJDEPE) to Cyanamid. A summary of the work efforts conducted as part of this literature search, as well as the results of this literature search, are provided in the enclosed attachment.

The 28 TIC compounds were initially identified in Attachment 5A of Cyanamid's August 22, 1991 letter responding to NJDEPE comments on the Soils RI Report/FS Work Plan. These TICs were targeted based upon a frequency of detection greater than 5 percent and/or soil concentration greater than 10 ppm for volatile organic compounds (VOAs) or 100 ppm for base-neutral/acid extractable compounds (BNAs).

Based on the results of the attached literature search, coupled with the site-wide concentrations and distribution of these 28 TICs, additional work efforts to address the TICs issue is not warranted. The attached documentation supports this conclusion for the reasons highlighted below.

1. The Endangerment Assessment already includes chemicals of interest that are closely related to several of the TICs (e.g., naphthalene). This suggests that the chemicals previously identified, for which there are toxicity factors, would drive a simultaneous cleanup of soils contaminated with chemicals of interest and TICs.

SECTION 1 - INTRODUCTION

This discussion describes the known toxicological properties/adverse health effects associated with a targetted list of 26 groups of chemicals or specific chemicals identified as Tentatively Identified Compounds (TICs) at the American Cyanamid Bound Brook facility. Some of the TICs have previously been addressed as chemicals of interest in the Endangerment Assessment (EA) for the site. The chemical summaries in Section 2 provide overviews of the toxicological characteristics of the chemicals or chemical groups based upon a detailed review of 16 toxicology sources or on-line databases (see Section 4 - References). The health effects that are described have generally been documented from laboratory animal experiments, or from occupational exposure of humans. Thus, these health effects are not specifically related to the chemical concentrations detected at the site. Toxicity information for TICs listed as "isomers" is based on the parent compound or similar chemicals since no specific identification is provided. On-line databases (i.e. IRIS, HSDB) for the majority of TICs currently contain little or no information about the toxicity of these compounds. The discussion of compounds for which toxicity data were not readily located contains a statement to this effect.

The "Known" and "Known Group" TICs addressed in this document are:

1. dimethyl naphthalene isomer;
2. trimethylnaphthalene isomers;
3. naphthalene;
4. dichlorobenzene isomer;
5. trichlorobenzene isomers;
6. trimethyl benzene isomer;

asthmatic bronchitis, fatigue, conjunctivitis, nausea, and narcosis (Sittig, 1985). Inhalation exposure may result in chemical pneumonitis at the site of contact when deposition of liquid trimethyl benzenes occurs in the lungs (Sittig, 1985).

2.4 Amines

8. diethyl benzenamine isomer;
9. methyl benzenamine isomer;
10. N,N-diethyl-benzeneamine;
11. N,N-dimethyl-methanamine;

N,N-dimethylmethanamine (trimethylamine) is a moderately toxic material; contact can cause skin burns and eye irritation (Sittig, 1985). It is a naturally occurring degradation product of nitrogenous plant and animal substances (Merck, 1989). Inhalation of vapors causes coughing and vomiting; higher concentrations may cause difficulty breathing and pulmonary edema (Sittig, 1985). Little is known of the actual toxicology of this substance and case histories are rare (HSDB, 1991a). The other compounds listed above are related to benzenamine (aniline). The toxicity of aniline is discussed in the following subsection. In general, exposure to aniline compounds results in cardiovascular, central nervous system (CNS), liver, and kidney effects (Sax, 1984).

2.4.1 12. Aniline

Direct toxic actions of aniline include decreased blood pressure and cardiac arrhythmia. Exposure to aniline may result in depression of the CNS, jaundice, or occasionally malignant growths in the bladder (Sax, 1984). Localized dermal contact may result in skin irritation. Exposure

to aniline has resulted in cardiovascular and CNS effects; the liver and kidney are also affected (Sax, 1984). The action of aniline in the body causes the formation of methemoglobin resulting in cyanosis. Aniline is classified by USEPA in Group B2, a probable human carcinogen.

2.5 Benzothiazoles

13. 2-methylthio benzothiazole;
14. benzothiazole;
15. benzothiazole isomer;
16. mercaptobenzothiazole isomer;

Benzothiazole is toxic by ingestion (Sax & Lewis, 1987). Mercaptobenzothiazole (MBT) is moderately toxic; a probable oral lethal dose of MBT for humans is 0.5-5.0 grams/kg, or between one ounce and one pint for an average adult (i.e. 150 lbs) (HSDB, 1991b). Human exposure to significant amounts of MBT is rare (HSDB, 1991b). MBT is usually encountered in rubber products and causes some dermatitis. Garments containing rubber contaminated with MBT have reportedly caused skin irritation, and MBT may irritate the eyes (HSDB, 1991b). In animal experiments, seizures were induced in individuals given extremely high doses of MBT (335 mg/kg) (HSDB, 1991b).

2.6 Furans

17. 3-phenyl-furan;
18. phenyl furan isomer;

Contact with liquid furan should be avoided as it may be absorbed through the skin. Pure furan can react vigorously with oxidizing materials when exposed to heat or flame. Furan vapors have narcotic properties, and furan exposure via inhalation of vapors caused circulatory disturbance in experimental animals (Windholz, 1983).

2.7 Other:

2.7.1 19. 1,1,2-trichloro-1,2,2-trifluoro-ethane

1,1,2-trichloro-1,2,2-trifluoro-ethanes, known as fluorocarbons or "freons", are used as refrigerants and propellants in many types of aerosol products in the U.S. Heating of freon may produce phosgene, chloride, and fluoride gases (HSDB, 1991c) which can enter the body via inhalation, ingestion, or skin and eye contact (Sittig, 1985). Harmful effects associated with exposure to freons include throat irritation, dermatitis, and drowsiness (Sittig, 1985). Points of attack include the skin and heart (Sittig, 1985). Animal experiments with freon produced severe corneal damage in instances of short-term high-dosage exposure (HSDB, 1991c). Inhalation of freon vapors causes pulmonary edema, bronchial constriction, and lung irritation (HSDB, 1991c). Freon displaces oxygen in the lungs, and is very toxic when inhaled in high concentrations and/or for extended periods of time (HSDB, 1991c).

2.7.2 20. PCB isomer

Since PCBs were widely used in industry for over 40 years, a significant database is available concerning the human health effects associated with long-term occupational exposure to relatively high levels of PCBs. Workers have been primarily exposed to PCBs via inhalation and skin absorption exposure, with PCBs subsequently accumulating in

the liver and fatty tissues. The only documented human health problem associated with long-term exposure to high concentrations of PCBs is a form of dermatitis known as chloracne (Mather, 1987). However, it is unclear whether the observed cases of chloracne resulted from PCBs or exposure to polychlorinated dibenzofurans, a potential impurity in some PCB mixtures and a known cause of chloracne (Kimbrough et al, 1987). Certain symptoms of exposure, such as chloracne, skin irritation, eye and upper respiratory irritation, and increases in liver enzyme activity, have been attributed to exceptionally high levels of PCBs via direct dermal contact and inhalation (Kimbrough et al., 1987). PCBs can be absorbed through the digestive system, respiratory tract, and the skin. Initially, PCBs concentrate in the liver, blood, and muscle, but ultimately accumulate in the adipose tissue and skin. PCBs can be transferred to young mammals either transplacentally or through breast milk. A number of epidemiologic studies on occupational and accidental exposure to PCBs have been performed. None of these studies of human exposure, including those sponsored by the National Cancer Institute and National Institute for Occupational Safety and Health (NIOSH), concluded that PCB exposure is associated with an increased incidence of cancer. PCBs are currently classified as Group B2 probable human carcinogens, based on laboratory animal data for the highly chlorinated Aroclor-1260 mixture.

2.7.3 21. Dimethyl nitrobenzene isomer

Dimethyl nitrobenzene (nitroxylenes) is toxic by inhalation, skin absorption, and ingestion (Sax, 1987). Nitroxylenes attack the blood, liver, kidneys, and cardiovascular system. Harmful effects include anoxia, cyanosis, and lung, liver, and kidney damage (Sax, 1987).

2.7.4 22. Dimethyl ethyl methyl phenol isomer

Dimethyl phenol is toxic by ingestion and skin absorption (Hawley, 1985). No other toxicity information for this compound was located.

2.7.5 23. 2(3H)-Benzothiazolethione

No toxicity information for this compound was located.

2.7.6 24. 4-Chlorobenzene sulfonamide

No toxicity information for this compound was located.

2.7.7 25. 2-hydroxy-4-methoxy-methanone/-benzophenone

When heat is applied, methanone compounds emit toxic fumes (Sax, 1984). Inhalation exposure may cause respiratory distress, bronchitis, or pneumonitis (HSDB, 1991d). Contact with the eyes may result in irritation, pain, swelling, and sensitivity to light (HSDB, 1991d). No other toxicity information for this compound was located.

2.7.8 26. Methylthio-benzothiazolethione

No toxicity information for this compound was located.

HSDB, 1989d. Hazardous Substance Data Bank. Offline Printout of HSDB 2-hydroxy-4-methoxy-benzophenone. October 1991. Oak Ridge National Laboratory, Oak Ridge, TN.

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Sittig, Marshall, 1985. Handbook of Toxic and Hazardous Chemicals and Carcinogens. Noyes Publications, Park Ridge, NJ.

Windholz, Martha, 1983. The Merck Index; Tenth Edition. Merck & Co.,
Rahway, NJ.



State of New Jersey
Department of Environmental Protection and Energy
Division of Responsible Party Site Remediation

CN 028
Trenton, NJ 08625-0028
Tel. # 609-633-1408
Fax. # 609-633-1454

Scott A. Weiner
Commissioner

Karl J. Delaney
Director

03 DEC 1991

CERTIFIED MAIL
RETURN RECEIPT REQUESTED
NO. P 713-404-106

J.B. Reid, Vice President
Chemical Products Division
American Cyanamid Company
One Cyanamid Plaza
Wayne, NJ 07470

NO. P 713-404-107
C.S. Forsyth, Plant Manager
Lederle Laboratories
A Division of American Cyanamid Company
Bound Brook, NJ 08805

Dear Gentlemen:

Re: American Cyanamid Company
Bridgewater Township, Somerset County

The New Jersey Department of Environmental Protection and Energy (NJDEPE) and the U.S. Environmental Protection Agency (USEPA) has reviewed your letter dated October 31, 1991 concerning Supplemental Tentatively Identified Compounds (TICs) evaluation as part of Soils Remedial Investigation (RI)/Feasibility Study (FS) Work Plan.

The approach to the TICs evaluation is adequate with the inclusion of following:

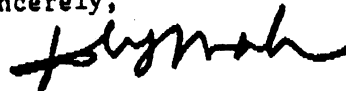
1. Compounds that are analyzed as known analytes of specific Target Compound List (TCL) fractions and have already been addressed in the Endangerment Assessment (EA) do not need to be addressed in the TIC evaluation. Examples of such compounds are Naphthalene and PCBs. Both of these are identified in their respective analyte fraction (BNAs and Pest/PCB respectively), but both may occur as TICs in other fractions.
2. If definitive toxicological information is available on a specific TIC compound, and this compound is of a sufficiently high concentration (greater than 100 ppm) with a high frequency (greater than 20% of the samples) then this information should be incorporated into the EA. Please note that the analysis of

TICs has a high degree of underactivity which should be factored into the risk such that TIC driven risks must be greater than the quantitative uncertainty of the risk. Do not, however apply toxicological information for a specific compound to a family of compounds in the EA. The discussion of the toxicological characteristics of individual compounds under family discussion is appropriate since in many cases this is the only data available on the TIC constituents, but uncertainty in both concentration and toxicology makes credible evaluation impossible at this time.

Please submit the final soils RI/FS work plan to the NJDEPE and USEPA incorporating all previous comments with TIC evaluation within thirty (30) days after the approval of EA.

If you have any questions, please contact me at (609) 633-1455.

Sincerely,

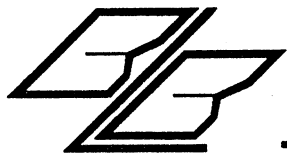


Haiyesh Shah, Case Manager
Bureau of Federal Case Management

kj

c: Joel Jerome, American Cyanamid, Bound Brook
Joyce Harney, USEPA
Mike Infurna, USEPA
Andrew Marinucci, DPFSR/BEERA
Marc Romanell, DPFSR/BGWPA
Paul Richter, DPFSR/ETRA

RECEIVED
DEC 05 1991
JOEL JEROME



Attachment 5

ATTACHMENT 5
GENERALIZED AREAS OF SIGNIFICANT CONTAMINATION

GENERALIZED AREAS OF SIGNIFICANT CONTAMINATION

A summary of the analytical data for areas of the site where NJDEPE Soil Action Levels are exceeded is provided in Figures B-1 through B-6. These figures list only the "chemicals-of-interest" as identified in the December 1990 (Amended March 1992) Baseline Site-Wide Endangerment Assessment.

Using these data summaries, several maps were prepared showing the subsurface soil sampling locations where specific chemicals-of-interest exceeded the NJDEPE Soil Action Levels by factors of 1, 10, and 100. Additionally, maps were prepared to show the monitoring well locations where ground-water samples exceeded state and federal drinking water standards (see Attachment 2A of August 22, 1991 letter).

From the above-referenced maps, a single comprehensive site map delineating the approximate boundaries of the areas of significant contamination in soils and ground water was developed (see Figure 5-1). These "generalized areas of significant contamination" are defined according to the following conditions:

1. The areas contain a cluster of sampling points in which multiple chemicals-of-interest are detected at concentrations above the NJDEPE soil action levels;
2. Chemicals-of-interest are detected in soils and ground water in or around the same area;

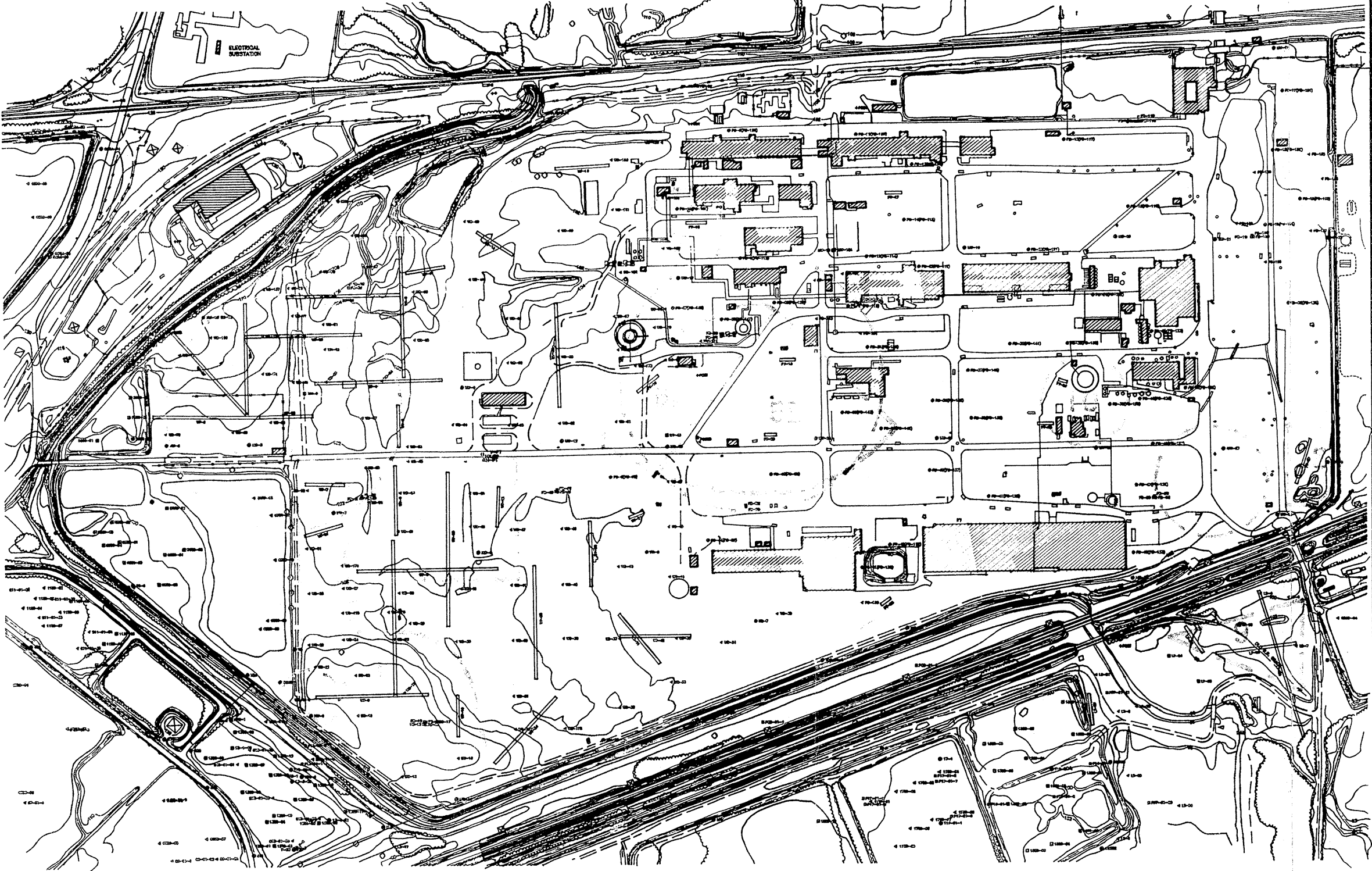
4. Areas where significant concentrations of contaminants other than those on the list of "chemicals-of-interest" could potentially impact remedial objectives due to their presence in soil and ground water.

When reviewing these areas it is important to recognize that the boundaries in this figure are approximations only and that a refined delineation of these areas cannot be completed with the existing data base. A summary of the specific chemicals-of-interest contributing to each area of significant contamination is presented in Table 5-1.

TABLE 5-1

AMERICAN CYANAMID COMPANY GENERALIZED AREAS OF SIGNIFICANT CONTAMINATION DETECTED CHEMICALS OF INTEREST IN SOILS AND GROUNDWATER																																											
COMPOUNDS	SOILS AREAS											GROUND-WATER BENEATH THE FOLLOWING SOILS AREAS																															
	1	2	3	4	5	6(A)	6(B)	7	8	9	10	[1,2 & 3]	[4]	[5,6A & 6B]	[8 & 10]																												
VOLATILE (VOAs)																																											
1,1,-Dichloroethene																																											
Carbon Disulfide							X					*	*	*																													
Acetone							X		X		X	*	*	*																													
Toluene	X	X	X	X	X	X	X		X	X	X	*	*	*																													
Methylene Chloride			X				X			X	X	*	*																														
Xylenes (Total)	X	X	X	X	X	X	X		X	X		*	*	*																													
Ethylbenzene	X	X	X	X	X	X	X	X	X	X		*	*	*	*																												
Chlorobenzene	X	X	X	X	X		X				X	*	*	*	*																												
Benzene	X	X	X	X	X	X			X	X		*	*	*	*																												
Chloroform																																											
Trichloroethene					X																																						
Tetrachloroethene																																											
SEMI-VOLATILES (SVs)																																											
Nitrobenzene	X		X	X	X	X		X			X	*		*																													
Naphthalene	X	X	X	X		X	X		X	X		*	*	*																													
2-Methylnaphthalene	X	X	X			X			X	X		*		*																													
1,2-Dichlorobenzene	X		X	X	X					X			*	*																													
1,4-Dichlorobenzene					X								*	*																													
4-Chloroaniline	X											*	*																														
1,2,4-Trichlorobenzene											X	*			*																												
Bis(2-ethylhexyl)phthalate											X																																
NOTES:																																											
1. X - INDICATES THAT THE COMPOUND WAS DETECTED IN THE SOILS AREA WITH A CONCENTRATION GREATER THAN 10 TIMES THE SOILS ACTION LEVEL (1 ppm VOAs and 10 ppm SVs).																																											
2. * - INDICATES THAT THE COMPOUND WAS DETECTED BENEATH THE SOILS AREA WITH A CONCENTRATION EXCEEDING AN MCL/A-280 OR GREATER THAN 0.30 ppm WHERE NO STANDARD EXISTS.																																											
<table><tr><th>AREA</th><th>HISTORICAL DESCRIPTION</th><th>AREA</th><th>HISTORICAL DESCRIPTION</th></tr><tr><td>1</td><td>Area of general plant debris disposal</td><td>6(B)</td><td>Area of former stills</td></tr><tr><td>2</td><td>Area of general plant debris and dye sludge disposal</td><td>7</td><td>Area of former aniline production</td></tr><tr><td>3</td><td>Area of equipment storage and disposal</td><td>8</td><td>Area of former waste pits</td></tr><tr><td>4</td><td>Area of former waste pits</td><td>9</td><td>Area used for Iron oxide drying</td></tr><tr><td>5</td><td>Area of underground storage tanks</td><td>10</td><td>Fuel oil tank area</td></tr><tr><td>6(A)</td><td>Area of former tank farm</td><td></td><td></td></tr></table>																AREA	HISTORICAL DESCRIPTION	AREA	HISTORICAL DESCRIPTION	1	Area of general plant debris disposal	6(B)	Area of former stills	2	Area of general plant debris and dye sludge disposal	7	Area of former aniline production	3	Area of equipment storage and disposal	8	Area of former waste pits	4	Area of former waste pits	9	Area used for Iron oxide drying	5	Area of underground storage tanks	10	Fuel oil tank area	6(A)	Area of former tank farm		
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FIGURE 5-1



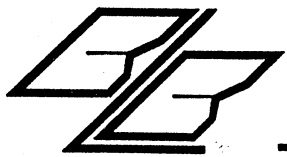
LEGEND

APPROXIMATE AREA OF
SOILS CONTAMINATION

APPROXIMATE AREA OF
GROUND-WATER
CONTAMINATION

AMERICAN CYANAMID
BOUND BROOK, NEW JERSEY

GENERALIZED AREAS OF
SIGNIFICANT CONTAMINATION



Attachment 6

ATTACHMENT 6

**SOILS/WASTE VOLUME COMPARISONS AND
CONTAMINANT MASS ESTIMATES**

SOILS/WASTE VOLUME COMPARISONS AND CONTAMINANT MASS ESTIMATES

In order to assess the potential impact that contaminated soils and impoundment wastes might have on ground water in the future, the mass of organic contaminants contained in soils and impoundment wastes was estimated from the database. These estimates were made based on the total volume of soils or impoundment wastes in an area of interest and the average concentration of contaminants detected in subsurface samples. The results of this analysis are presented in Tables 6-1 and 6-2. Calculations are described in the footnotes to this table.

TABLE 6-1

AMERICAN CYANAMID COMPANY
COMPARISON OF WASTE VOLUME AND CONTAMINANT MASS ESTIMATES
FOR SUBSURFACE SOILS AND IMPOUNDMENT WASTES

<u>Potential Source</u>	<u>Estimated Volume of Contaminated Soil/Waste¹(CY)</u>	<u>Estimated Mass of Organic Contamination (Tons)²</u>
Subsurface Soils	53,000	230
Group 1 Impoundments (excluding Impoundment 20)	94,000	380
Group 2 Impoundments	340,000	21
Group 3 Impoundments	165,000	6,400
Group 4 Impoundments	44,000	1,700

- 1 The volume of contaminated soil in the subsurface soils was calculated as follows:

The surface area of the delineated area was obtained with a planimeter and multiplied by the average depth to native soil obtained from the logs for all of the subsurface samples in the delineated area. This product yielded the volume of contaminated soil in a single area. The volumes of all 11 areas were added to obtain the total volume.

The volume of contaminated waste in the impoundments was obtained as follows:

The total volumes of the impoundments were obtained directly from the Impoundment Characterization Program Final Report. (August 1990)

- 2 Mass of organic contamination in the subsurface soils calculated as follows:

The volume of contaminated soil obtained as described above was multiplied by the average concentration of total volatile and semivolatile compounds, including TICs, of the subsurface samples in the delineated area. This product, after multiplied by conversion factors, yielded the mass of organic contamination in tons per area. The masses for all 11 areas were added to obtain the total mass. (The conversion factors used were: 100 pounds of soil per cubic foot of soil; 0.4536 kilograms per pound; 2.2 pounds per 1,000,000 milligrams; and one ton per 2,000 pounds).

Mass of organic contamination in the impoundments was calculated as follows:

The volume of contaminated waste obtained as described above was multiplied by the average concentrations of total volatile and semivolatile compounds detected in each impoundment. This product, after multiplied by conversion factors, yielded the mass of organic contaminants in tons per impoundment. This process was repeated for each impoundment within a group. These masses were summed to obtain a total mass of contaminant per group. (The conversion factors used varied for each impoundment e.g. density and percent solids).